THE

AGRICULTURAL LEDGER.

1898—No. 10.



SILK,

(MULBERRY.)

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. VI., Pt. III. S. 1822.*]



SALE OF RAW SILK FOR THE KASHMIR DARBAR.

Official Papers including Memoranda on the Sale by SIR GEORGE BIRDWOOD, K.C.I.E., *opinions of* SIR THOMAS WARDLE, KT., *and other experts consulted, etc.*



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INTRODUCTORY.

The following papers on the subject of the sale of Kashmir silk in London afford information which it seems likely may be of interest to those *engaged in the silk trade. They are accordingly* published for information The two Memoranda prepared by Sir George Birdwood, K.C.I.E., will be found to contain full details of the sales as well as the opinions of the brokers, merchants, manufacturers and special experts who were consulted. It will be observed that in his second Memorandum Sir George Birdwood expresses the opinion that given perfect reeling the prospect of Kashmir silk being sold at a profit in Europe is decidedly hopeful.

KASHMIR SILK.

Memorandum on sale of raw Silk for the Kashmir Darbar, 24th February 1896.

Sir George Birdwood's memorandum.

In July 1895, Mr. Walter Roper Lawrence, C.I.E., I.C.S, brought, on behalf of the Kashmir Darbar, some samples of raw mulberry silk to this office for valuation, in the London market. Mr. [now Sir] Thomas Wardle, of Leek, to whom the samples were referred by the Secretary of State in Council, reported most favourably on them, and his report was forwarded to the Government of India for transmission to the Kashmir Darbar, on the 5th of December

The objects of THE AGRICULTURAL LEDGER are :—

(1) To provide information connected with agriculture or with economic products in a form which will admit of its ready transfer to ledgers;

(2) To secure the maintenance of uniform ledgers (on the plan of the Dictionary) in all offices concerned in agricultural subjects throughout India, so that references to ledger entries made in any report or publication may be readily utilised in all offices where ledgers are kept;

(3) To admit of the circulation, in convenient form, of information on any subject connected with agriculture or economic products to officials or other persons interested therein;

(4) To secure a connection between all papers of interest published on subjects relating to economic products and the official Dictionary of Economic Products. With this object the information published in these ledgers will uniformly be given under the name and number of the Dictionary article which they more especially amplify. When the subject dealt with has not been taken up in the Dictionary, the position it very possibly would occupy in future issues of that work will be assigned to it.

for the Kashmir Darbar.

KASHMIR SILK. Sir George Birdwood's memorandum.

Bernard, K.C.S.I., Mr. Lawrence, Mr. Rose, the Technical Assistant in the Revenue and Statistics Department here, and myself, when, for the reasons set forth in Mr. Lawrence's minute (Appendix B), the tender of the Messrs Henckell and Du Boisson was accepted.

Conf. pp. 6, 7.

The following table shows the valuations put on the consignment under its three qualities, by four experts, and the three firms who tendered for it, in whole or in portions :—

	No. 1 Quality.	No. 2 Quality.	No 3 Quality.	REMARKS.
Experts—	Per lb	Per lb	Per lb	
1. Mr. Wardle	*10s. 6d.*	*10s.*	*8s. 9d.*	
2 Another silk manufacturer .	*10s. 3d.*	*9s.*	*8s 6d.*	
3. A silk merchant . . .	*9s.*	*8s. 3d.* *8s 6d.*	*7s. 6d.*	
4 A Macclesfield expert . .	*11s*	*10s.—11s.*	*10s.*	
Tenderers—				
1. Messrs. Worthington & Co. .	—	—	*10s.*	The firm paying all dock charges.
2. Messrs. Milner & Co. . .	*12s. 6d.*	—	—	
3. Messrs Henckell, Du Boisson & Co.	*12s. 9d.*	*10s. 9d*	*10s. 9d.*	

It will be seen that Messrs. Henckell, Du Boisson & Co. not only made the highest tender for the whole consignment, but that they offered also to defray all the dock charges, which really raised their tender to *13s*, *11s.* and *11s.* for the three qualities, respectively. There can be no doubt, therefore, of the soundness, in every respect, of the acceptance of their tender.

From annexed statement of the sale account (Appendix C), it will be seen that the total sum realised for the silk was *1,244l.* for *2,143* lb the average price on the stock being about *11s. 7¼d.** per lb. It will be noticed from the statement that the deduction for damaged silk as determined by "the dock examination and weightment," amounted to 8lb (see Appendix); that 2lb were used up as samples; and that Mr. Wardle received 16lb of No 1, 21½lb of No. 2, and 12lb of No. 3, or 49½lb altogether, on condition that he prepared therewith effective samples of woven silks for the approaching exhibitions of silks and cabinet furniture at the Bethnal Green Museum (under the direction of the Lords of the Committee of Council on Education) and of Indian products at

Conf. pp. 7, 8.

* Equal to R9-15-1 per lb at an exchange of *1s. 2d.* per rupee

for the Kashmir Darbar.

KASHMIR SILK. Sir George Birdwood's memorandum.

Bernard, K.C.S.I., Mr. Lawrence, Mr. Rose, the Technical Assistant in the Revenue and Statistics Department here, and myself, when, for the reasons set forth in Mr. Lawrence's minute (Appendix B), the tender of the Messrs. Henckell and Du Boisson was accepted.

Conf. pp. 6, 7.

The following table shows the valuations put on the consignment under its three qualities, by four experts, and the three firms who tendered for it, in whole or in portions :—

	No. 1 Quality	No. 2 Quality.	No. 3 Quality.	REMARKS.
Experts—	Per ℔	Per ℔	Per ℔	
1. Mr. Wardle	10*s*. 6*d*.	10*s*.	8*s*. 9*d*.	
2 Another silk manufacturer .	10*s*. 3*d*.	9*s*.	8*s* 6*d*.	
3. A silk merchant . . .	9*s*.	8*s*. 3*d*. 8*s* 6*d*.	7*s*. 6*d*.	
4. A Macclesfield expert . .	11*s*	10*s*.—11*s*.	10*s*.	
Tenderers—				
1. Messrs. Worthington & Co. .	—	—	10*s*.	The firm paying all dock charges.
2. Messrs. Milner & Co. . .	12*s*. 6*d*.	—	—	
3. Messrs Henckell, Du Boisson & Co.	12*s*. 9*d*.	10*s*. 9*d*.	10*s*. 9*d*.	

It will be seen that Messrs. Henckell, Du Boisson & Co. not only made the highest tender for the whole consignment, but that they offered also to defray all the dock charges, which really raised their tender to 13*s*, 11*s*. and 11*s* for the three qualities, respectively. There can be no doubt, therefore, of the soundness, in every respect, of the acceptance of their tender

From annexed statement of the sale account (Appendix C), it will be seen that the total sum realised for the silk was 1,244*l*. for 2,143 ℔ the average price on the stock being about 11*s* 7¼*d*.* per ℔ It will be noticed from the statement that the deduction for damaged silk as determined by "the dock examination and weightment," amounted to 8℔ (see Appendix), that 2℔ were used up as samples; and that Mr. Wardle received 16℔ of No. 1, 21½℔ of No. 2, and 12℔ of No. 3, or 49½℔ altogether, on condition that he prepared therewith effective samples of woven silks for the approaching exhibitions of silks and cabinet furniture at the Bethnal Green Museum (under the direction of the Lords of the Committee of Council on Education) and of Indian products at

Conf. pp. 7, 8.

* Equal to R0-15-1 per ℔ at an exchange of 1*s*. 2*d* per rupee.

SILK: Mulberry.

Sale of raw Silk

KASHMIR SILK.

Sir George Birdwood's memorandum.

1895. Mr. Wardle had in his report strongly advised that the stock of raw silk retained by the Darbar, pending the results of Mr. Wardle's examination of the samples drawn from it, should be shipped direct to London, and sold here, instead of being disposed of in the Calcutta market; and Mr. Lawrence, concurring in this advice, the Government of India were asked by telegraph on the 23rd of October 1895, to inform the Kashmir Darbar that it was desirable that the silk should at once be sent to London. On the 29th of November last Mr. R. Mukerji, the Director of Sericulture, Kashmir, wrote to me (see Appendix A) that, under the orders of the Darbar, sixteen cases of raw silk had been addressed to me for sale in London. These cases I duly received on the 28th of January this year, and four of them were at once opened, and samples drawn from each, and sent to various brokers, merchants, and manufacturers, including Mr. Thomas Wardle, who had undertaken to distribute samples of the silk beyond the range of possible purchasers commanded by myself. The sixteen cases contained silk of three qualities, in the following proportions:—

Conf. pp. 5, 6.

No. 1 quality	9 bales.
No. 2 ,,	3 ,,
No. 3 ,,	4 ,,

The tenders received were as follows:—

Tender 1.

Messrs. Henckell, Du Boisson & Co., 18, Laurence Pountney Lane, London, E.C., offered for the whole consignment, for—

	s.	*d.*	
No. 1 quality	12	9	per pound.
No. 2 ,,	10	9	,,
No. 3 ,,	10	9	,,

Tender 2.

Messrs. William Milner & Sons, Leek, offered for the whole of—
No. 1 quality . . . 12*s.* 6*d.* per pound.

Tender 3.

Messrs. Worthington & Co., Leek, offered for the whole of—
No. 3 quality . . . 10*s.* per pound.

No offer for No. 2 quality other than that of Messrs. Henckell, Du Boisson & Co, was received.

The above three tenders were discussed at an informal meeting at the India Office on the 24th of February last, between Sir Charles

for the Kashmir Darbar. | SILK: Mulberry.

KASHMIR SILK.

inform you that the Accountant General at this Office has been instructed to forward to you a draft for *2l. 2s.* in discharge of Messrs. Clowes's account with you

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Appendices.

APPENDICES.

APPENDIX A.

From R. Mukerji, Esq., *Director of Sericulture, Kashmir, to* Sir George Birdwood, K.C.I.E., *No. 55 S., dated 29th November 1895.*

I have the honour to state that, under order of the Jammu and Kashmir State Council, I have forwarded to your address, through Messrs. King, King & Co., of Bombay, 16 un-lined boxes of silk thread for sale.

The enclosed list gives all the necessary information about the silk in the boxes.

ENCLOSURE IN ABOVE.

Invoice of raw silk.

Quality and Quantity of Raw Silk consigned to Sir George Birdwood, K.C.I.E., *the India Office, Whitehall, London, S. W., through* Messrs. King, King & Co., *Bombay.*

Quality.	No of boxes.	Quantity					Insured value.			Remarks.
		No of *skeins.*	Weight.							
			Maund	Seer	Chittack	Tolas	*R*	*a*	*p*	
No 1 . .	1	2,127	2	37	14	2¼	2,697	9	3	At R25 per seer
" .	2	1,611	2	1	15	3¼	2,049	7	3	
" . .	3	1,720	2	7	8	0¾	2,187	11	9	
" . .	7	1,000	1	13	14	0¾	1,347	0	6	
" . .	8	1,549	2	2	4	1	2,056	9	0	
" . .	9	1,000	1	12	12	1¼	1,319	3	6	
" . .	10	800	1	0	14	3¼	1,023	15	6	
" . .	11	1,003	1	10	0	2¾	1,250	12	6	
" . .	12	1,369	2	27	2	4	1,679	6	0	
Total .	Nine	13,177	15	24	6	4¼	15,610	11	3	
Carried over .	...		...	...			...			

SILK : Mulberry.

Sale of raw Silk

KASHMIR SILK. Invoice of raw silk.

Quality and quantity of Raw Silk consigned to Sir George Birdwood, K.C.I.E., *the India Office, Whitehall, London, S. W., through* Messrs. King, King & Co., *Bombay*—continued.

Quality.	No of boxes	QUANTITY.					Insured value.	Remarks
		No of skeins	Weight.					
			Maund	Seer	Chittack	Tolas	R a p.	
Brought forward	.	.	..		.	.	.. ...	
No. 2 . .	4	2,029	2	24	11	1½	2,512 13 9	At R24 per seer.
,, . .	15	1,300	1	30	8	1	1,692 4 9	
,, . .	16	1,005	1	13	15	1	1,294 12 9	
Total .	Three	4,334	5	29	2	3½	5,499 15 3	
No. 3 . .	5	1,139	1	20	11	4½	1,214 14 0	At R30 per seer.
,, . .	6	1,000	1	12	1	3½	1,042 2 0	
,, .	13	1,306	1	29	4	1½	1,395 6 0	
,, . .	14	519	...	27	11	2	554 4 0	
Total .	Four	3,964	5	9	13	1½	4,196 10 0	
GRAND TOTAL.	Sixteen	10,475	25	23	6	4	15,307 4 6	

APPENDIX D.

Mr. Lawrence's minute.

By the kind invitation of Sir George Birdwood I attended at the India Office to-day. The question of the prices offered for the Kashmir silk was discussed in the presence of Sir Charles Bernard, Sir George Birdwood, Mr. Rose, and myself.

The prices offered by Messrs. Henckell, Du Boisson & Co. are higher than those offered by Messrs. Milner & Sons. By Sir George Birdwood's calculation,—

	Quality.		
	1	2	3
Messrs. Henckell, Du Boisson & Co. offer for .	13	11	11
Messrs. Milner & Sons	12-3	...	9-9

for the Kashmir Darbar.

KASHMIR SILK.

Mr. Lawrence's minute.

From the price point of view it is to the advantage of the Kashmir State to accept the offer of Messrs. Henckell, Du Boisson & Co

The only doubt which arises is whether it would be in the interests of the future of Kashmir silk to sell direct to manufacturers like Messrs. Milner & Co. The object of the Kashmir State is to advertise the fact that good silk can be produced in Kashmir. I think that *merchants* like Henckell, Du Boisson & Co., are just as likely to push and advertise the Kashmir silk as manufacturers such as Milner & Co. I also raised the question whether Henckell and Du Boisson, in the interests of their Bengal silk business, were trying to get the Kashmir silk into their hands in order (*a*) to extinguish a rival industry, (*b*) to force it into the trade channel of Calcutta. Sir George Birdwood who knows the firm well reassures me on these points, and he feels sure that Henckell & Co. are *bonâ fide* purchasers who hope to make a handsome profit out of their purchase, and who will, in the ordinary way of business, make Kashmir silk known to the trade.

I therefore representing Kashmir as *amicus curiæ*, think it would be wise to accept the offer of Messrs. Henckell, Du Boisson & Co.

WALTER R. LAWRENCE.

The 24th February 1896

APPENDIX C.

Statement of Sale Account, 16 Bales Kashmir Silk.

Sale accoun

		lb	oz.		£ s d	£ s. d
9	Bales, No 1 quality, net weight 1,258lb —					
	Messrs Henckell & Co	1,234	6	at 12s. 9d	786 18 3	
	Messrs. Milner & Co.	5	0	at 12s 6d	3 2 6	
	Mr. Wardle	16	0			
	Deduct damaged	2	0			
	„ samples	0	10			
	TOTAL	1,258	0			790 0 9
3	Bales, No. 2 quality, net weight 464lb —					
	Messrs. Henckell & Co.	440	0	at 10s 9d.	236 10 0	
	Mr. Wardle	21	8			
	Deduct damaged	2	0			
	" samples	0	8			
	TOTAL	464	0			236 10 0
		Carried forward			..	1,026 10 9

SILK : Mulberry.

KASHMIR SILK.

Invoice of raw silk.

Sale of raw Silk

Quality and quantity of Raw Silk consigned to Sir George Birdwood, K.C.I.E., *the India Office, Whitehall, London, S. W., through* Messrs. King, King & Co., *Bombay*—continued.

Quality.	No. of boxes.	Quantity.					Insured value.			Remarks
		No of skeins	Weight.							
			Maund.	Seer	Chittack.	Tolas	R	a.	p.	
Brought forward	...	...	...		...	...	......			
No. 2 . .	4	2,029	2	24	11	1½	2,512	13	9	At R24 per seer.
" . .	15	1,300	1	30	8	1	1,692	4	9	
" . .	16	1,005	1	13	15	1	1,294	12	9	
Total .	Three	4,334	5	29	2	3½	5,499	15	3	
No 3 . .	5	1,132	1	20	11	4½	1,214	14	0	At R20 per seer.
" . .	6	1,000	1	12	1	3½	1,042	2	0	
" . .	13	1,306	1	29	4	1½	1,395	6	0	
" . .	14	519	...	27	11	2	554	4	0	
Total .	Four	3,954	5	9	13	1½	4,195	10	0	
Grand Total.	Sixteen	20,475	15	23	6	4	15,307	4	6	

APPENDIX D

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	Quality.		
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WALTER R. LAWRENCE.

The 24th February 1896.

APPENDIX C.

Statement of Sale Account, 16 Bales Kashmir Silk.

Sale account.

		lb	oz.		£	s.	d.	£	s.	d
9	*Bales, No. 1 quality, net weight 1,258lb* —									
	Messrs Henckell & Co .	1,234	6	at 12*s*. 9*d*	786	18	3			
	Messrs. Milner & Co. .	5	0	at 12*s*. 6*d*.	3	2	6			
	Mr. Wardle . . .	16	0							
	Deduct damaged . .	2	0							
	" samples . . .	0	10							
	TOTAL .	1,258	0					790	0	9
3	*Bales, No. 2 quality, net weight 464lb* —									
	Messrs. Henckell & Co. .	440	0	at 10*s*. 9*d*.	236	10	0			
	Mr. Wardle . .	21	8							
	Deduct damaged . .	2	0							
	" samples . .	0	8							
	TOTAL .	464	0					236	10	0
	Carried forward .				..			1,026	10	9

SILK: Mulberry.

Sale of raw Silk

KASHMIR SILK.

Sale account.

APPENDIX C.

Statement of Sale Account, 16 Bales Kashmir Silk—contd.

		lb	oz		£	s	d.	£	s	d.
	Brought forward .				...			1,026	10	9
4	Bales, No. 3 quality, net weight 421lb —									
	Messrs. Henckell & Co .	394	0	at 10s. 9d.	212	18	0			
	Messrs Whittles & Co .	5	0	at 10s	2	10	0			
	Messrs Worthington & Co	5	0	at 8s. 3d.	2	1	3			
	Mr. Wardle . . .	12	0							
	Deduct damaged . . .	4	0							
	" samples . . .	1	0							
	TOTAL .	421	0					217	9	3
								1,244	0	0

APPENDIX D.

From Messrs Henckell, Du Boisson & Co., *to* Sir G. C. M. Birdwood, K.C.I.E., etc., *dated 4th March 1896*

We thank you for your favours of the 29th ultimo. We enclose herewith dock weight account, showing net weight . 2,063lb—

	lb	oz.	
Sorting account showing	29	12	stained.
" " "	9	0	damaged and cut.
In all . . .	38	12	unsound.

On which the allowance is assessed at 8lb

Net weight to be paid for 2,055lb

The damage has been assessed in the customary way, that is, no allowance is made in the price, but a deduction is made from the weight.

We annex account of the silk, including the samples received from you, showing total value, 1,236*l.* 6*s.* 3*d.*, against which we have already paid you 850*l.* and we now enclose cheque for 386*l.* 6*s.* 3*d.* in settlement of the balance.

Further testings give the range of No. 1 quality as 11 to 17 deniers, No. 2, 14 to 20 deniers, and No. 3, 18 to 37 deniers. Evidently much more supervision of the reeling is required.

for the Kashmir Darbar.

SILK: *Mulberry.*

KASHMIR SILK.

ENCLOSURE 1 IN ABOVE.

Account of 16 Cases Kashmir Silk.

Sale account.

	lb	lb		£	s.	d.
9 Bales, No. 1 quality, net weight	1,235					
Deduct for damage	2					
		1,233 at 12s 9d. per lb		786	0	9
3 Bales, No. 2 quality, net weight	441					
Deduct for damage	2					
		439 at 10s. 9d. per lb		235	19	3
4 Bales, No. 3 quality, net weight	387					
Deduct for damage	4					
		383 at 10s. 9d. per lb		205	17	3
Add samples—						
4th February, No. 1, 1lb 6 ozs at 12s. 9d.				0	17	6
" " Nos. 2/3, 2lb at 10s. 9d.				1	1	6
12th February, No. 3, 10lb at 13s.				6	10	0
				£1,236	6	3

ENCLOSURE 2 IN ABOVE.

Messrs Henckell, Du Boisson & Co.

London and India Docks Joint Committee.

Copy of Damage Account, 2nd March 1896.

16 Bales Kashmir Raw Silk, Land Carriage, February 1896.

No.	lb	ozs.		No.	lb	ozs.	
1	1	12	Stained	4	3	4	Stained
"	1	8	Cuts		3	0	Damaged.
2	2	0	Stained		0	8	Cuts.
3	...		Sound.	15	...		Sound.
7	...		Do.	16	1	4	Stained.
8	...		Do.	5	7	8	Do.
9	...		Do.	6	6	4	Do.
10	...		Do.		2	12	Damaged.
11	...		Do.	13	6	0	Stained.
12	...		Do.		1	4	Cuts.
				14	2	0	Stained.

J. ROMBELLS, *Foreman.*

J. BUDD, *Warehouse Keeper.*

SILK: Mulberry.

Sale of raw Silk

KASHMIR SILK.

Re-weight account.

ENCLOSURE 3 IN ABOVE.

London and India Docks Joint Committee.

Re-weight Account, 29th February 1896.

16 Bales Kashmir Silk, Henckell, Du Boisson & Co., 29th February 1896, Land Carriage, 27th February 1896.

No.	Weight.			Tare, etc.		Net lb
	Cwt.	qrs.	lb	2 oz.	draft.	
1	1	3	4	8	5	195
2	1	2	2	12	...	165
3	1	2	14	12	...	177
7	1	0	1	8	...	108
8	1	2	3	12	...	166
9	0	3	27	8	...	106
10	0	3	2	0	3	83
11	0	3	21	8	5	100
12	1	1	0	12	...	135
4	1	3	23	4	...	213
15	1	1	7	12	..	142
16	0	3	5	4	3	86
5	0	3	16	4	...	97
6	0	3	26	3	5	105
13	1	1	5	4	.	140
14	0	1	20	12	5	45

R SWEENEY.
J. BUDD.

APPENDIX F.

Mr. (now Sir Thomas) Wardle's report.

Report on Kashmir Raw Silk by Mr. Thomas Wardle, F.C.S., *President of the Silk Association of Great Britain and Ireland—dated Leek, Staffordshire, the 11th October 1893.*

I have carefully examined the samples of Kashmir silk on which you requested me to report in your letter of the 11th July. I have conducted the inquiry on the basis of my examinations of the various colonial silks on which I was requested to report in 1886 by the Royal Commission of the Colonial and Indian Exhibition. A reference to that report will be found useful for the purpose of comparison.

I have consulted several experts on whose judgment I can rely as to the commercial value of the samples from two points of view; one, that of merchants and silk brokers, the other of manufacturers. In addition, I give my own estimate of the value.

The merchants and silk brokers who supply the manufacturer of course require their profit, and naturally estimate the value at less than the manufacturer, who has to pay that profit. On this point, with particular reference to the problem of the successful development of sericulture in Kashmir, I will say a few words further on.

KASHMIR SILK.

Mr. (now Sir Thomas) Wardle's report.

Cocoons.

I have not had the advantage of examining the cocoons from which these samples of silk were obtained, but, judging from the latter, I am of opinion that the silk is not that of the *desi* (*i. e.*, "country" Bombyx fortunatus) or the Madrasi worm (Bombyx crœsi) of Bengal, but probably of the mulberry worm (Bombyx Mori) of Europe, a univoltine species, presumably from one or more of the cultivated races of Italy, or France, or both; and as it is the species which yields the silk of commerce of France, Italy, China, and Japan, it is, I think, admirably suited to Kashmir, and on the whole superior to the abovementioned multivoltine species of Bengal.

As no cocoons have been sent with the samples of raw silk and waste I have received for examination, I have not been able to give the particulars of the first six denominations in the following table, which is based on that I devised for my aforesaid Report on Silks at the Colonial and Indian Exhibition.

Samples examined.

The nine examples of Kashmir silk received are of the following states and qualities.

Two samples, Nos. 1 and 2, of silk waste accompany the seven hanks of raw silk. One is made up as the ordinary *chassum* of Bengal, the other as ordinary silk waste.

The seven samples of raw silk (Nos. 3 to 9) consist of—

One skein of 1st quality white gum.
" " " " yellow gum.
" " 2nd " "
" " 3rd " "
" " 4th " "
" skein from very poor cocoons.
" " double cocoons.

The reelable thread of the cocoon is composed of two cylindrical fibres, each termed in France "brin." They are simultaneously seriposited by the silkworm from orifices on each side of its head, and are termed in France "bave." They consist of a homogeneous substance termed fibroin; they are surrounded and cemented together by a substance resembling gelatine or gum, named in chemistry "sericin" or

S. 1822.

SILK: Mulberry.

Sale of raw Silk

KASHMIR SILK.

Re-weight account.

ENCLOSURE 3 IN ABOVE.

London and India Docks Joint Committee.

Re-weight Account, 29th February 1896.

16 Bales Kashmir Silk, Henckell, Du Boisson & Co., 29th February 1896, Land Carriage, 27th February 1896.

No.	Weight.			Tare, etc.		Net lb
	Cwt.	qrs.	lb	2 oz.	draft.	
1	1	3	4	8	5	195
2	1	2	2	12	...	165
3	1	2	14	12	...	177
7	1	0	1	8	...	108
8	1	2	3	12	..	166
9	0	3	27	8	...	106
10	0	3	2	0	3	83
11	0	3	21	8	5	100
12	1	1	0	12	...	135
4	1	3	22	4	...	213
15	1	1	7	12	...	142
16	0	3	5	4	3	86
5	0	3	16	4	...	97
6	0	3	26	3	5	105
13	1	1	5	4		140
14	0	1	20	12	3	45

R. SWEENEY.
J. BUDD.

APPENDIX E.

Mr. (now Sir Thomas) Wardle's report.

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KASHMIR SILK.

Mr. (now Sir Thomas) Wardle's report.

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,, ,, double cocoons.

The reelable thread of the cocoon is composed of two cylindrical fibres, each termed in France "brin." They are simultaneously seri-posited by the silkworm from orifices on each side of its head, and are termed in France "bave." They consist of a homogeneous substance termed fibroin; they are surrounded and cemented together by a substance resembling gelatine or gum, named in chemistry "sericin" or

KASHMIR SILK.

Report of Lyons conditioning house.

silk gelatine, technically termed in England "gum," and in France *grès*. This gum constitutes about 25 to 33 per cent. of the total weight, and is easily dissolved and removed by boiling in soap solution, previous to the silk being dyed.

The statement on pages 13 and 14 gives all the leading particulars of my examination of the above nine examples in a tabular form.

Report of the Lyons Conditioning House.

I sent the samples to the Lyons Conditioning House, with a request that they would be so good as to give the Government of India an opinion on the silk, both as to its value and to its properties

I enclose the conditioning notes, which show results which may be taken as closely approximate to my own conclusions. They have not reported on the values of the samples. However, the values I send may be regarded as accurate, as I have taken great pains to check them. Since I valued them the prices stated in my table may be safely placed about 5 to 10 per cent. higher, owing to a recent rise in the raw silk markets in England and France which, owing to a greatly increased demand, will probably be maintained for some time yet.

for the Kashmir Darbar.

SILK: Mulberry.

KASHMIR SILK.

Report of Lyons conditioning house.

TABULAR STATEMENT.

Species Bombyx Mori, *probably Univoltine.*

No.	Description.	First quality Yellow.	First quality White.	Second quality.	Third quality.	Fourth quality.	From very poor Cocoons.	From Doppio Cocoons	Frison.	Chassam.	No
1	Weight of cocoon . . .										1
2	Dimensions of cocoon . .	No cocoons sent.									2
3	Weight of bave reeled from cocoon.										3
4	Length of bave reeled from cocoon.		...	...	...	...	...	...		...	4
5	Mean percentage of silk reeled from cocoon										5
6	Mean percentage of waste or frison in the cocoon.										6
7	Number of baves composing the raw silk thread, *i.e.*, the number of cocoons used to produce the thread.	4	4	4	7	9	Very variable.	Most variable.	...	...	7
8	Size in deniers in hank of 520 yards.	10 to 12 deniers.	10 to 11 deniers.	10 to 15 deniers.	17 to 18 deniers.	28 deniers	...	...	...	...	8
9	Mean diameter of brin or cocoon single fibre.	$\frac{1}{3600}$ inch	$\frac{1}{3200}$ inch	$\frac{1}{3200}$	[illegible]	[illegible]	$\frac{1}{1500}$	$\frac{1}{1500}$	...	...	9
10	Mean diameter of bave or cocoon double fibre.	$\frac{1}{1700}$ inch	$\frac{1}{1200}$	$\frac{1}{1000}$	$\frac{1}{1200}$	$\frac{1}{1100}$	$\frac{1}{1100}$	$\frac{1}{1200}$	...	...	10

SILK: Mulberry.	Sale of raw Silk

KASHMIR SILK.

Report of Lyons conditioning house.

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for the Kashmir Darbar

SILK: Mulberry.

KASHMIR SILK.

Report of Lyons conditioning house.

Décret du 25 Juin 1856.

Condition Publique des Soies, Laines et Cotons.

Bureau de Titrage.

N° d'ordre, 1607. Lyon, le 26 Septembre 1895.

Echantillon, 1st quality, skein yellow.

Déposé par M, Association Anglaise.

Observations.				Titre.	
				en grammes et centig.	en deniers.
				0·65	12·24
				0 65	12·24
				0·65	12 24
				0 65	12 24
				0 70	13·18
				0·70	13·18
				0·70	13·18
				0 70	13 18
Elasticité.	Ténacité.	Tors.	Filage.	0 70	13·18
				0·70	13·18
20%	35 Grmes			0 70	13 18
21	40			0·70	13·18
22	45			0·70	13·18
23	50			0 70	13·18
2	55				
				9 60	180 76
Titre ordinaire sur 500 mètres				0 685	12·91
Poids conditionné				9 67	
Titre conditionné sur 500 mètres				0 689	12·97
Ancien titre sur 476m — ordinaire					12·29
Ancien titre sur 476m — conditionné					12·34

Droit de titrage, Fcs 2.

S. 1822.

SILK: Mulberry.

KASHMIR SILK.

Report of Lyons conditioning house.

Sale of raw Silk

TABULAR STATEMENT.

Species Bombyx Mori, *probably Univolline*—continued.

No.	Description.	First quality Yellow.	First quality White	Second quality.	Third quality.	Fourth quality.	From very poor Cocoons.	From Doppio Cocoons.	Frison.	Chassum	No.
11	Mean tenacity or strength of the thread of raw silk.	24 drams	20·8 drams	32 drams	38·5 drams	44 drams	...	...	...	...	11
12	Mean elasticity or tension of the thread of raw silk.	4 inches	3·9 inches	5·1 inches	5·5 inches	5·2 inches	8·2 inches	...	...	...	12
13	Mean tenacity or strength of the brin	3 drams	3 drams	3 drams	2⅜ drams	2$\frac{1}{10}$ drams	.	...	...	...	13
14	Mean elasticity or tension of the brin.	4 inches	3·9 inches	5·1 inches	5·5 inches	5·2 inches	...	...	...	...	14
15	Net weight of silk per lb. after removal of its gum.	12 oz. 7 drams.	12 oz. 12 drams.	12 oz. 5 drams.	11 oz. 14 drams	11 oz. 11 drams.	...	...	...	...	15
16	Colour of raw silk in gum	Yellow	White	Yellow	Yellow	Yellow	Yellow	Yellow	...	...	16
17	Merchant's and broker's valuation per lb.	9s.	9s.	8s. 3d. to 8s. 6d.	7s. 9d.	7s. 9d.	6s. 6d.	2s.	1s. 3d. to 1s. 4d.	1s.	17
18	A Leek manufacturer's skilled expert's valuation per lb.	10s. 3d.	10s. 3d.	9s.	8s. 6d.	8s.	6d.	3s.	...	...	18
19	My valuation	10s. 6d.	11s. 6d.	10s.	8s. 9d.	8s. 6d. to 9s.	7s. 6d. to 8s.	3s. 6d.	1s. 8d.	1s. 6d.	19
20	A skilled Macclesfield expert's valuation per lb.	11s.	12s.	10s. to 11s.	10s.	8s. to 9s.	7s. 6d. to 8s.	2s.	1s. 6d.	1s. 6d	20
21	Lyons conditioning house, size in deniers of 520 yards, compare with No. 8	12$\frac{1}{16}$ deniers	11½ deniers	15 deniers	19$\frac{4}{15}$ deniers	18 deniers	39½ deniers	113 deniers	..	...	21

S. 1822.

for the Kashmir Darbar

SILK: Mulberry.

KASHMIR SILK.

Report of Lyons conditioning house.

Décret du 25 Juin 1856.

Condition Publique des Soies, Laines et Cotons.

Bureau de Titrage.

Nº d'ordre, 1607. Lyon, le 26 Septembre 1895.

Echantillon, 1st quality, skein yellow.

Déposé par M. Association Anglaise.

Observations.				Titre. en grammes et centig	Titre. en deniers.
				0·65	12·24
				0 65	12·24
				0·65	12·24
				0 65	12 24
				0 70	13·18
				0·70	13·18
				0·70	13·18
				0·70	13·18
Elasticité	Ténacité.	Tors.	Filage.	0·70	13·18
				0·70	13·18
20%	35 Gmes			0 70	13·18
21	40			0·70	13·18
22	45			0 70	13·18
23	50			0 70	13·18
2	55				
				9 60	180·76

Titre ordinaire sur 500 mètres	0·685	12·91
Poids conditionné	9·67	
Titre conditionné sur 500 mètres	0·689	12 97
Ancien titre sur 476m — ordinaire		12·29
Ancien titre sur 476m — conditionné		12 34

Droit de titrage, Fcs 2.

SILK: Mulberry.

KASHMIR SILK.

Report of Lyons conditioning house.

Sale of raw Silk

Décret du 25 Juin 1856.

Condition Publique des Soies, Laines et Cotons.

Bureau de Titrage.

N° d'ordre, 1606. Lyon, le 26 Septembre 1895.

Echantillon, 1st quality, skein white.

Déposé par M, Association Anglaise.

Observations.				Titre.	
				en grammes et centig.	en deniers.
				0·60	11·29
				0·60	11·29
				0·60	11·29
				0·60	11·29
				0·60	11·29
				0 60	11·29
				0·60	11·29
				0·65	12·24
				0·65	12·24
Elasticité.	Ténacité.	Tors	Filage.	0·65	12·24
20%	30 mm			0·65	12·24
20	35			0·65	12 24
21	40			0·70	13·18
21	45			0·70	13·18
22	50			0·70	13·18
				0·70	13·18
				10·25	192 95
Titre ordinaire sur 500 mètres				0·64	12·05
Poids conditionné				10·26	
Titre conditionné sur 500 mètres				0·641	12·07
Ancien titre sur 476m — ordinaire					11·47
Ancien titre sur 476m — conditionné					11·49

Droit de titrage, Fcs 2.

S. 1822.

for the Kashmir Darbar.

SILK: Mulberry

KASHMIR SILK.

Report of Lyons conditioning house.

Décret du 25 Juin 1856.

Condition Publique des Soies, Laines et Cotons.

Bureau de Titrage.

N° d'ordre, 1508. Lyon, le 26 Septembre 1895.

Echantillon, 2nd quality, skein yellow.

Déposé par M. Association Anglaise.

Observations.				Titre en grammes et centig.	Titre en deniers.
				0·75	14·12
				0·75	14·12
				0·80	15·06
				0·80	15·06
				0·80	15·06
				0·80	15·06
				0·85	16·00
				0·85	16·00
				0·85	16·00
Elasticité.	Ténacité.	Tors.	Filage.	0·85	16·00
20%	50 G^mes			0·90	16·94
21	55			0·90	16·94
22	60			0·90	16·94
23	65			0·90	16·94
24	70			0·90	16·94
				12·60	237·18
Titre ordinaire sur 500 mètres				0·84	15·81
Poids conditionné				12·65	
Titre conditionné sur 500 mètres				0·843	15·87
Ancien titre sur 476^m ordinaire					15·05
Ancien titre sur 476^m conditionné					15·10

Droit de titrage, F^rs, 2.

S. 1822.

SILK: Mulberry.

KASHMIR SILK.

Report of Lyons conditioning house.

Sale of raw Silk

Décret du 25 Juin 1856.

Condition Publique des Soies, Laines et Cotons.

Bureau de Titrage.

N° d'ordre, 1609. Lyon, le 26 Septembre 1895.

Echantillon, 3rd quality, skein yellow.

Déposé par M, Association Anglaise

Observations				Titre.	
				en grammes et centig	en deniers.
				1'00	18 83
				1'00	18'83
				1'05	19'77
				1'05	19'77
				1'05	19'77
				1 05	19 77
				1'05	19'77
				1'05	19'77
Elasticité.	Ténacité.	Tors	Filage	1'10	20'71
				1'10	20 71
20%	75 Gms			1'10	20'71
21	80			1'10	20'71
22	85			1'10	20'71
22	90			1'15	21'65
23	95			1'15	21'65
				16'10	303'13
Titre ordinaire sur 500 mètres				1'073	20'20
Poids conditionné				16'20	
Titre conditionné sur 500 mètres				1'08	20'33
Ancien titre sur 476m ordinaire					19'23
Ancien titre sur 476m conditionné					19'35

Droit de titrage, Frs 2.

S. 1822.

for the Kashmir Darbar.

SILK: Mulberry.

KASHMIR SILK.

Report of Lyons conditioning house

Décret du 25 Juin 1856.
Condition Publique des Soies, Laines et Cotons.
Bureau de Titrage.
N° d'ordre, 1610. Lyon, le 26 Septembre 1895
Echantillon, 4th quality, skein yellow.
Déposé par M, Association Anglaise.

Observations.				Titre. en grammes et centig.	Titre. en deniers.
				1·40	26·36
				1·40	26 36
				1 45	27 30
				1 45	27·30
				1 45	27 30
				1·50	28 24
				1 50	28·24
				1 55	29·19
				1 55	29 19
Elasticité.	Ténacité	Tors.	Filage.	1 55	29 19
20%	110Gmes			1·60	30 13
21	115			1 60	30·13
22	120			1·65	31 07
23	125			1 65	31·07
24	130			1·70	32 01
				1·70	32 01
				1·70	32 01
				26·40	497·10
Titre ordinaire sur 500 mètres				1·552	29 24
Poids conditionné				26·52	
Titre conditionné sur 500 mètres				1 56	29 37
Ancien titre sur 476m ordinaire					27·82
Ancien titre sur 476m conditionné					27·96

Droit de titrage, F · 2.

S. 1822.

SILK: Mulberry.	Sale of raw Silk

KASHMIR SILK.

Report of Lyons conditioning house.

Décret du 25 Juin 1856.

Condition Publique des Soies, Laines et Cotons.

Bureau de Titrage.

Nº d'ordre, 1612. Lyon, le 26 Septembre 1895.

Echantillon, Silk, very poor cocoons.

Déposé par M, Association Anglaise.

Observations.				Titre. en grammes et centig.	Titre. en deniers.
				1 30	24'48
				1'70	32'01
				1'75	32 95
				1'75	32 95
				1 80	33'89
				1 80	33 89
				1'85	34 83
				1'95	36'72
Elasticité.	Ténacité.	Tors.	Filage	2 00	37'66
				2'00	37 66
19%	100Gmes			2'05	38'60
20	105			2'10	39'54
20	110			2 35	44'25
21	115			2'45	46'13
22	120			2'95	55 55
				3'75	70'62
				3'85	72'50
				37'40	704'23
Titre ordinaire sur 500 mètres				2 20	41'42
Poids conditionné				37'51	
Titre conditionné sur 500 mètres				2'206	41'54
Ancien titre sur 476m ordinaire					39'43
Ancien titre sur 476m conditionné					39'54

Droit de titrage, F 2.

S. 1822.

for the Kashmir Darbar.

SILK: Mulberry.

KASHMIR SILK.

Report of Lyons conditioning house.

Décret du 25 Juin 1856.

Condition Publique des Soies, Laines et Cotons.

Bureau de Titrage.

N° d'ordre, 1611. Lyon, le 26 Septembre 1895.

Echantillon, Silk from double cocoons.

Déposé par M, Association Anglaise.

Observations.	Titre.	
	en grammes et centig.	en deniers.
	4'30	80'97
	5'20	97'92
	5'40	101'69
	5'45	112'05
	7'10	133'70
	7'20	135'59
	9'05	170'43

Elasticité.	Ténacité.	Tors.	Filage.
10%	200 Gmes		
12	260		
14	300		
16	340		
18	400		

	en grammes et centig.	en deniers.
	44'20	832'35
Titre ordinaire sur 500 mètres	6'314	118'90
Poids conditionné	44'40	
Titre conditionné sur 500 mètres	6'342	119'43
Ancien titre sur 476m — ordinaire		113'19
Ancien titre sur 476m — conditionné		113'69

Droit de titrage, Fcs 2.

SILK: Mulberry.

KASHMIR SILK.

Mr. (now Sir Thomas) Wardle's report.

Sale of raw Silk

Remarks.

The result of this examination convinces me that the silk of Kashmir is of as high a quality physically as any silk from any other part of the world, and that an important future is in store for Kashmir in a greatly extended sericultural output. Judging from these examples I am more than satisfied with the absolute suitability of Kashmir, in a climatic sense, for the production of silk of superior strength, roundness of fibre, and freedom from structural defects.

Improved Reeling.

If I may venture to mention a few necessary conditions and precautions, I would like to say that greater attention must be paid to the reeling of the cocoons. The samples point to the necessity for an improvement in the regularity of size in the structural condition of the multiple thread of raw silk by better reeling. This can easily be done by selecting the best form of tavelette, and more highly skilled cocoon sorters and reelers. The number of baves in each thread is too variable, the finer baves being at times reeled together instead of being reeled with coarser baves.

Healthy Surroundings.

The commercial value of the silk would be greatly enhanced by healthier conditions of production. Greater cleanness, greater size greater regularity of fibre, and greater freedom from duvet would thereby be attained, and these must be recognised as first requirements of success. Healthy surroundings, and good ventilation in the breeding magnaneries are the predetermining conditions of such success, and therefore of imperative importance.

The quality, although respectively good in the various grades, is not equal to filature Cantons, filature Japans, or Italians.

Attention to all these points would soon render it unnecessary for Europe to depend so largely upon supplies from the further East.

Capital and Security of Contract.

I may be travelling outside my instructions, but I am constrained to add that, as British capital will be required to fully develop the silk-producing resources of Kashmir, two things are, in my opinion, necessary.

S. 1822.

for the Kashmir Darbar.

SILK: Mulberr

First, that there should be absolute security of contract in Kashmir, and, second, that the Government should, in order to encourage the application of such capital, join in any attempt to produce silk on a large scale, providing some capital, and participating in the profit or in some equivalent way.

KASHMIR SILK.

Mr (now S Thomas Wardle's report.

Shipment direct.

I also feel sure that, if the silk could be shipped direct to London and there placed on the market through the brokers, avoiding Bombay and Calcutta altogether, the chances of profit would be materially enhanced. This more simple mode of transfer would greatly simplify matters, and would place the reeler much nearer to the consumer, and would reduce the number of profits before the silk gets into the consumer's hands, as is now unfortunately the case with our imports from Bengal, China, and Japan.

My visit to Bengal

It may be remembered that in 1886, at the instance of Mr. (now Sir) Edward C. Buck, I visited India, and reported on Bengal sericulture I enclose a copy of my report. The two principal causes which had led to a decline of sericulture there were bad reeling and an excessive mortality of the silkworms. I found that not less than 60 per cent. of the silkworms died of disease. I recommended the Government of India to send some competent person to France and Italy, and there to study at the Government sericultural laboratories of Montpelier and Padua all that related to the growth of the mulberry and the proper rearing of the silkworms. Sir E. C. Buck selected a young native, Mr. Nitya Gopal Mukerji, and sent him out as I had suggested. He was away about two years, and completed his studies by several months' most advantageous study in Monsieur Pasteur's laboratory in Paris of silkworm diseases and their prevention.

When Colonel Parry Nisbit was appointed to Kashmir he very kindly obtained for me a good deal of information about sericulture there, and I suggested that Mr. Mukerji, who had been installed in a sericultural laboratory at Berhampur, should be sent over to Kashmir and instal a laboratory there.

KASHMIR SILK.

Mr. [now Sir Thomas] Wardle's report.

Figured Brocades from Kashmir Silk.

This has, I believe, been done, because afterwards I received a letter from Mr. R. Mukerji, Director of Sericulture of Srinagar, Kashmir, informing me that he was sending some Kashmir silk for the Exhibition at Stafford House, London, in May 1894. I had the silk thrown, dyed, and woven for that Exhibition. The manufactured silk was a kind of furniture brocade, and attracted considerable attention. I had the honour of showing it to the Queen, who was very much interested with it. It was also seen by the Prince of Wales and most of the other members of the Royal family. The silk was woven by Messrs. Warner and Sons of Spitalfields and Braintree, who reported on it in a letter of which I enclose a copy *See* Appendix I.

Conf. below.

I also send herewith for inspection the piece of this figured brocade, all of which, or, at least, half of it, I should like to have returned when done with, as it is the first specimen of Kashmir silk dyed and woven in England.

Messrs. Warner informed me they would be glad to take all the silk that could be sent from Kashmir for some time if their suggestions were carried out.

I thought it well to add the above to my report, which, if considered superfluous, will be taken as showing the intense interest I have taken for several years past in the founding of a sericultural industry in Kashmir for the European markets.

From Messrs. Warner and Sons, *8, Newgate Street, London, to* Thomas Wardle, Esq.,—*dated the 12th May 1894.*

APPENDIX I.

Report of Messrs Warner and Sons.

We are glad to inform you that the Kashmir silk which we wove into a small piece of goods at our factory in Spitalfields seems to us to be the best we have ever seen from India; it is very strong, and very bright when dyed.

The sample was coarse in size, which might arise from having too many cocoons used in the reeling; but, if it could be obtained finer in size, its market price would be about equal to that of China silk, and it could then be brought in general use. Otherwise it would only be useful in certain fabrics, such as tapestry.

It gives us much pleasure to be able to report so favourably on a product of our Indian Empire.

S. 1822.

KASHMIR SILK.
Remarks by Mr. Lawrence.

APPENDIX II.

From Walter R. Lawrence, Esq., *22, Sloane Gardens, London, S. W., dated the 7th November 1891.*

I have the honour to acknowledge the receipt of your letter No. 1612, R. S., of yesterday. Mr. Wardle is correct in supposing that the silk is that of the Bombyx Mori of Europe, a univoltine species, and his general remarks are, for the most part, applicable to the condition of sericulture in Kashmir.

Practically, Kashmir is at present only working at one twenty-fourth of its full power. The valley is crowded with mulberry trees, but, owing to the difficulty of supervision, and to doubts as to the expediency of spending money on a scheme controlled by an amateur like myself, I have insisted on confining our efforts to a scheme which was self-supporting. Hence we did not attempt to introduce apparatus for improved reeling, nor have we spent money on "magnaneries." An Italian expert, Signor M. Bassi, now employed in wine making, accompanied me on inspections, and was of opinion that the erection of magnaneries was not necessary, and held that the ordinary Kashmir cottage, easily ventilated and easily warmed, was admirably suited to the rearing of silk worms.

If, however, improved reeling appliances and special magnaneries are introduced, they should only be introduced by European capital, and under the supervision of European experts The Kashmir State could never control operations on the scale which they will quickly attain if capital were forthcoming. The important factor in the future of sericulture in Kashmir is the presence of a large number of Kashmiris known as *kirm-kash* or "worm destroyers," who thoroughly understand the business of rearing silkworms and who only required skilled supervision. The local agency is present, all that is required is capital and European experts.

The next point in Mr. Wardle's remarks refers to "capital and security of contract." Security of contract is no doubt necessary, but I would urge that the Government should not join in the business. I would suggest that the Kashmir State should be asked to lease the right of collecting mulberry leaves, and to lease sufficient ground for the purpose of erecting filatures, and if need be, of magnaneries. The one objection which the Darbar has against European capital being introduced is that the capitalist would find fault with the legal institutions of the country and would seek the jurisdiction of the

SILK: Mulberry.	Sale of raw Silk

KASHMIR SILK.

Remarks by Mr. Lawrence.

Resident. If it were clearly stated that in all suits arising out of the business of sericulture the lessee would be subject to the jurisdiction of the Kashmir Courts, I believe that His Highness the Maharaja would consent.

I am strongly in favour of direct shipment. The Kashmir State will feel secure of fair treatment if its silk is sold under the "ægis" of the India Office, official or unofficial. It is somewhat nervous on this point, as an experiment in selling shawls in Paris some years ago was a signal failure. Another reason, perhaps fanciful, is that efforts have been made from time to time to bring Kashmir silk under the control of French houses.

I need not dwell on the importance of making some use of Kashmir's wealth of mulberry trees, nor on the advantages which would accrue to the labouring classes, to the peasants who regard sericulture as a cottage industry, and to the State. I should add that at present there are four Europeans carrying on business in Kashmir without hindrance and without friction.

APPENDIX F (1).

Manufacturers' reports.

From Thomas Whittle, Esq., H. E. W., *Leek, Staffordshire, to* Sir George Birdwood, K.C.I. E.,—*dated the 11th March 1896.*

Enclosed I beg to hand you cheque value *2l. 10s.* in payment of the 5lb sample of raw silk sent to me by Mr. Thomas Wardle of this town. *It was the third quality I had, and I consider it very satisfactory. If reeled up to 30 and 40 deniers it would suit the Leek trade. The better qualities would suit if reeled from 16 up to 24 deniers.*

APPENDIX F (2).

Manufacturer's Reports on Samples, received from Messrs Henckell, Du Boisson & Co., 11th February 1896.

FIRST REPORT.

"*No. 1, yellow.*—This we make nice bright silk with a good amount of bone or feel, a firm hard thread, but a little knibby.

"*No. 2.*—Not so good a colour as No. 1 nor so bright, has similar feel, but is more lumpy and dirty.

"*No. 3.*—Equal to No. 1 in cleanness, but like No. 2 in colour and lack of brightness.

KASHMIR SILK.

Manufacturers' reports.

"*White.*—The whiter skeins are as dirty as to 2 yellow, but soft, not firm or boney. The brown skein very similar, perhaps the cleaner of the two.

"We think the yellow samples partake much of the nature of Italian silk, but if the knibs and dirt had been kept out it would have been much improved. The white is softer and we think scarcely equal in value. We should like, however, to test 20 or 30lb before expressing a very definite opinion as to the value."

The firm that sent the above report asked us the price of the silk, and we answered "probably 14*s.* for No. 1, 13*s* 6*d.* for No. 2, and 13*s.* for No. 3," and in reply they write as follows:—

"The prices you name seem to us *outside value.* We are very full of silk and don't care to try all three qualities, but if you will send us 10lb of No. 3 we will test it."

SECOND REPORT.

"*1st.*—The silk should be banded with either boiled silk or spun and the bands are too tight.

"*2nd.*—Generally it is not regular, *i.e*, there are fine places in it, for instance, the sample yellow No. 2 ranges from 12 to 20 deniers, and No. 3 ranges from 16 to 24 deniers.

"*3rd.*—The strength is found good. The silk winds fairly well. In places it is soft and fluffy.

"The silk is such as should find a market here. It has more nerve than Bengal, but it is not so regular in size as Sindahs for instance. By this information you will be able to get at its value."

Memorandum on the sale in London of the second consignment of raw silk received from the Kashmir Darbar in June 1897.

Sir George Birdwood's memorandum.

In April last Captain J. L. Kaye, the Assistant Resident in Kashmir, wrote from Srinagar asking me to again assist the Darbar in selling in the London Market a consignment of raw silk of three qualities, five cases of the first quality, two of the second, and one of the third, weighing 832lb 8oz., and informing me that he had forwarded the cases to me through Messrs. King, King & Co., of Bombay. On the receipt of the consignment in June last, I decided to ask Messrs. Henckell, Du Boisson & Co of Laurence

SILK: Mulberry.	Sale of raw Silk

KASHMIR SILK.

Sir George Birdwood's memorandum.

Pountney Lane, to make an offer for the whole of the silk, or, failing that, to state on what terms they would undertake to dispose of the consignment in the open market. I felt that this firm were in a position to obtain a far better price for the silk than it was possible for me to get through any other channel.

The firm were unable to make any offer for the silk themselves, but stated that they would be pleased to dispose of it on behalf of the Kashmir Darbar at the highest price obtainable, and would do their best to get buyers who were most likely to help in the future development of the Kashmir silk industry. In acknowledging the receipt of the consignment Messrs. Henckell, Du Boisson reported "that the whole of the silk is in good condition, except a very trifling quantity which has been damaged, part of it by nails having been driven through the wood and tin into the silk and cutting it, the remainder of the damage being a few skeins that "had been stained before they were packed."

The five bales of No. 1 quality silk were sold in July at 10*s*. 9*d*. per ℔, and Messrs. Henckell, Du Boisson remark on this :—

"We consider this a very fair price for the silk. It is perhaps slightly better made than last year's consignment, but still it varies from 13 to 21 deniers in size, and though the nature of the thread is excellent, its great irregularity in size prevents its being used in the highest class of goods."

In September the two cases of the second quality silk were sold at 10*s*. per ℔ and in December the last case (third quality) was sold at 9*s*. per ℔.

The average price realized for the whole consignment was 10*s*. 5*d*. against an average of 11*s*. 7*d*. last year. The higher price given for the previous consignment was, I am informed, due to the buyers having considered the silk better spun than it proved to be when worked up, and in consequence the buyers were to some extent losers.

From the annexed statement of account of Messrs. Henckell, Du Boisson & Co. it will be seen that the total net proceeds realised by the whole consignment of 832℔ 8oz. of silk was £422 6*s*. 9*d*.

I am still of opinion that there is every hope of the Kashmir silk finding a profitable market in Europe, the one essential being perfect reeling.

The 16th December 1897. GEORGE BIRDWOOD.

S. 1822.

for the Kashmir Darbar.

SILK: Mulberry

KASHMIR SILK.

Account sales.

Account sales and net proceeds of Kashmir silk sold by order of Sir George Birdwood, K.C.I.E., *for account and risk of the Kashmir Darbar.*

Nos.		
No. I 1-5	.	5 Cases Kashmir silk
II 7-8	.	2 ,, ,, ,,
III 6	.	1 Case ,, ,,
		8 Cases.

Date	Particulars	£	s.	d.	£	s.	d.
1897 July 22 .	. Sold by private sale prompt 22nd October 1897 * . — 5 bales weighing net 572lb @ 10s. 9d. per lb Cash received 6th August .	307	9	0			
	Add—131 days' interest @ Bank of England rate due 15th December 1897	......			310	15	1
September 15.	Sold by private sale prompt 15th December 1897 — 2 bales weighing net 176lb 12oz @ 10s. per lb	88	7	6			
	Cash received 15th December 1897 . . .	. .			88	7	6
November 18.	Sold by private sale prompt 29th November 1897.— ½ bale weighing net 83lb. 8oz. at 9s per lb . . 832-4 Cash received 29th December . .	37	11	6			
	Add—16 days' interest @ Bank of England rate due 16th December 1897	....			37	12	9
					436	15	1

* 5lb inferior quality taken out of this lot and included in No III quality

Charges.

Date	Particulars	£	s.	d.	£	s.	d.
July 1 .	. Dock charges	4	12	8			
	Rent	0	16	4			
	Reeling	1	7	0			
	Interest on charges	0	2	4			
	Petty expenses and postages . . .	0	5	0			
	Fibre insurance	0	15	0			
	Brokerage ½ per cent. . . .	2	3	4			
	Commission 1 per cent. . . .	4	6	8			
					14	8	4
	Value 15th December 1895				422	6	9

E. E.

LONDON:
The 15th December 1897.

HENCKELL, DU BOISSON & CO.

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Editor, Dr. George Watt, Reporter on Economic Products to the Government of India, Calcutta.

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THE

AGRICULTURAL LEDGER.

1898—No. 11.

ANANAS SATIVA.

(PINE APPLE.)

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. I., A. 1045-57.*]

PINE APPLE FIBRE.

Review of Correspondence showing results of a chemical examination in the Scientific Department of the Imperial Institute of a sample of the fibre prepared in Assam.



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OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING, INDIA.
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Price 1 anna or 1d.

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(Vegetable Product Series, No. 42.)
(Fibres.)

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INTRODUCTORY.

The Honourable Mr. Buckingham, C.I.E., of Amguri, Assam, forwarded to the Reporter on Economic Products a small sample of pine apple fibre for valuation by an expert The sample was considered too small to send to the Imperial Institute It was accordingly submitted to the Calcutta Chamber of Commerce with a request that, if possible, a note might be furnished as to quality and market value of the fibre. The Secretary to the Chamber replied, stating that on inquiry it had been ascertained there was no local market for such material, and that hence a valuation could not be given. The Secretary suggested, however, that a quotation for the fibre might possibly be forthcoming in London.

The attempt to obtain an Indian valuation having failed, the sample was transmitted to the Imperial Institute London, for favour

ANANAS sativa. | Pine Apple

IMPERIAL INSTITUTE.

of expert's opinion. On its reaching Sir F. A. Abel he kindly wrote as follows :—

From Sir F. A. Abel, Bart., K.C.B., *Honorary Secretary and General Director, Imperial Institute, to* George Watt, Esq, M.B, C.M, C.I.E., *Reporter on Economic Products to the Government of India, Indian Museum, Calcutta, —No. 186–3 (Flying Seal Series, No. 112), dated London, the 29th May 1897.*

With reference to a sample of pine apple fibre from Assam, which has been handed to me by Mr. Royle, for submission to practical Experts, I have to state that enquiry has been made of one of our Referees as to whether a few pounds of the material can be supplied at once for textile purposes, as he believes he is enabled to have this done by a new process, which is giving good results with other fibres.

I thought it right to communicate this enquiry to you without loss of time.

This was replied to by R. E. P No. 1415—67 F.S., dated the 6th July 1897, stating that a further sample had been asked for. R. E. P. No. 1636—67 F. S., dated the 4th August 1897, subsequently advised the despatch of a *further quantity, 3lb, of the pine apple fibre in* question. The following communication was received in due course from the Imperial Institute :—

From Sir F A. Abel, Bart., K C.B, *Honorary Secretary and General Director, Imperial Institute, to* George Watt, Esq., M B, C M, C.I.E, *Reporter on Economic Products to the Government of India, Indian Museum, Calcutta, —No. 347–3 (Flying Seal Series, No. 131), dated London, the 4th November 1897.*

Referring to your letters of the 6th July and the 4th August, sent in response to my application for a somewhat larger sample of pine apple fibre than that forwarded by you to Mr. Royle in January of this year, I have now the pleasure of communicating to you the results of chemical examination of the fibre, and the opinion furnished by our Expert Referee for fibres with regard to its quality and value.

The results furnished by examination of the specimen first received, by the comparative method followed in all instances in the Scientific Department, are as follows :—

The fibre contained 0·9 per cent. of mineral constituents or ash ; 11·33 per cent. of moisture in its normally dry condition ; and the percentage of cellulose was 80·87. Its loss in weight by submission to (A) Hydrolysis amounted to 14·21 per cent. and by (B) Hydrolysis

A. 1045-57.

to 18·12 per cent. Treated by the mercerising process it lost 17·32 per cent.; its acid purification entailed a loss of 1·52 per cent.; and it gained 35·83 per cent. by nitration.

CHEMICAL EXAMINATION RESULTS.

The average length of the ultimate fibre was 2·6 min., but, on submission of the second sample received to practical tests, the yield of "line" or long spinning fibre was much higher in proportion than that obtained from medium European flax; and the spinning qualities of the long, as well as of the shorter fibre, are reported to be good The second sample received was too small to yield exact practical results, but, so far as can be judged by its behaviour, the fibre is very promising in character, and, when well prepared, yields material, more nearly resembling flax in character than hemp which would be very suitable for spinning into fine twine, and for textile purposes, if it be properly softened.

Compares favourably with European Flax.

It is considered that the results furnished by the sample under examination are sufficiently good to warrant the recommendation that a sample shipment of at least five tons be made to England for trial purposes. That quantity would suffice to yield exact practical results on a fair working scale, as to its application by spinners, etc., to various purposes. The fibre would have to be submitted to a preparing process which would not be costly, and would be available for use in India if it be considered desirable eventually to treat it on the spot, after its value had been thoroughly determined here.

Shipment in quantity suggested.

At the present time, the value of fairly clean fibre in the London market would probably be from £20 to £25 per ton. A specimen of the "line" or long thin fibre furnished by the sample operated upon, is forwarded herewith

Valuation.

Regarding the question of supplying the fibre in considerable quantity, the R. E. P. replied as under :—

From George Watt, Esq., M.B, C M, C I.E., *Reporter on Economic Products to the Government of India, Indian Museum, to* Sir F A. Abel, Bart, K C B, *Honorary Secretary and General Director, Imperial Institute, London,—No. 2851—67 F. 8, dated Calcutta, the 22nd December 1897.*

I have the honour to acknowledge, with thanks, the receipt of your letter No 347—3 (Flying Seal Series No. 121), dated the 4th November last, communicating the results of chemical examination of a sample of pine apple fibre and of the opinion furnished by the Expert Referee for fibres of the Imperial Institute with regard to its quality and value. The sample in question was furnished by the

QUESTION of a LARGER SUPPLY.

Honourable Mr. J. Buckingham, who obtained it from a small experimental cultivation of the plant at Amguri in Assam.

With reference to the proposal now made for the supply of five tons of the fibre, I have the pleasure to forward herewith an extract from my letter No. 2738—67, dated the 9th instant, to the address of Mr. Buckingham. My ability to comply with your request for so large a quantity will very greatly, if not entirely, depend on Mr. Buckingham's reply.

Extract from letter No. 2738—67, dated the 9th December 1897, to the Honourable Mr. J. Buckingham, *Amguri, Assam.*

In continuation of previous correspondence (ending with this office No. 1606—67, dated the 2nd August 1897), I have now the pleasure of forwarding to you copy of the report just to hand from the Imperial Institute on your sample of pine apple fibre furnished with yours of the 15th July last. I enclose a very small sample of the fibre as cleaned by the experts of the Institute. You will see that the report is of a most encouraging nature. I shall be glad to hear from you with regard to the proposal to furnish the Institute with five tons of the fibre. I fear that is beyond your present capability, and that, before you could do so, it would be necessary to lay out a fairly large experimental plot. From what I saw of the luxuriant growth of the pine apple in your garden and indeed all over Assam, I should think it highly probable that you may be instrumental in the establishment of a new industry to the province. I should like to have your views on the matter before any further action is taken. . . . If you contemplate starting the industry on a large scale and would rather that publicity was not, however, given to the results so far attained, I shall of course publish nothing for a time.

The following letter and its enclosure shows action taken so far in the matter of obtaining the larger supply of pine apple fibre as suggested by the Expert Referee at the Imperial Institute:—

From George Watt, Esq., M.B., C.M., C.I.E., *Reporter on Economic Products to the Government of India, to* Sir F. A. Abel, Bart., K.C.B., *Honorary Secretary and General Director, Imperial Institute, London,—No. 2923—67 F.S., dated Calcutta, the 30th December 1897.*

In continuation of my letter No 2851—67 F. S., dated the 22nd December 1897, on the subject of pine apple (Ananas sativa)

Mr. Buckingham will ultimately fulfil his engagement.

Extract from letter, dated the 18th December 1897, from the Honourable Mr J. Buckingham, C I E., *Amgari, Assam.*

I am much obliged to you for your letter of the 9th instant regarding pine apple fibre: it is very satisfactory to learn that the fibre is so well reported on. As you observe, it is out of the question getting any quantity now, as the plant must be grown especially for fibre and not fruit; it is necessary to grow the plants in shade and the fruit under such influence is practically *nil.*

I shall at once lay out about 5 acres as an experimental plot I have enough plants now for at least 3 acres.

I am much obliged for the help you have given me in this. By all means publish whatever you think fit about the fibre.

G. I. C. P. O.—No 182 R. & A.—5-9-98.—2225.—H R.

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1898—No. 12.

DAUCUS CAROTA.

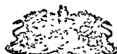
(THE CARROT.)

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. III., D. 173-94*]

CARROT CULTIVATION AS AN EMERGENT CROP

AT SEASONS OF THREATENED SCARCITY OR FAMINE.

Note on the general conclusions established by the results of the experimental cultivation in the North-Western Provinces and Oudh of Carrots from imported seed during the rabi *seasons of 1896-97 and 1897-98.*



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(Agricultural Series, No. 27.)
(Food Substances.)

THE

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1898—No. 12.

DAUCUS CAROTA.

(THE CARROT.)

[*Dictionary of Economic Products, Vol. III.*, D. 173-94.]

CARROT CULTIVATION AS AN EMERGENT CROP AT SEASONS OF THREATENED SCARCITY OR FAMINE.

Note on the general conclusions established by the results of the experimental cultivation in the North-Western Provinces and Oudh of Carrots from imported seed during the rabí *seasons of 1896-97 and 1897-98.*

Introductory.

In the "Famine Commission Report," 1881 (*East India Papers*), Sir Edward Buck, Kt., C.S.I., contributed a note dated 6th October 1878 "on the use of carrots and other root crops by the agricultural population of the North-West Provinces during times of scarcity." The opinion expressed by Sir Edward Buck was that carrots, if sown early enough in the autumn, would probably afford a valuable supplementary food-crop during winter famines in Northern India. After the failure of the *kharif* harvest of 1877 in the North-West Provinces, the cultivation of carrots rose to three or four times the ordinary extent, and would have increased much more had seed been obtainable.

Sir E. Buck's proposals.

The scarcity of 1896 led to grave apprehensions in official circles, and famine relief measures were established in nearly every district in the country. Another opportunity presented itself of testing the value of a fast-growing root-crop, and practical effect was given to the suggestions of Sir Edward Buck. Accordingly, several tons of "Mediterranean" carrot seed were ordered with as little possible delay from

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Importation of carrot seed.

Europe, and on its arrival in India in November it was distributed as widely as circumstances would permit for experimental cultivation in the North-West Provinces.

A memorandum on the details of the purchase in Europe of the carrot seed with observations on the botanical, agricultural and dietetical history of carrots was drawn up by Sir George Birdwood, K.C.I.E. The results of the cultivation in this country of the imported seed are summarised in the following letters submitted to Government by the Director of Land Records and Agriculture, North-Western Provinces.

From J. S. Meston, Esq., *Director, Department of Land Records and Agriculture, North-West Provinces and Oudh, to the Secretary to the Government, North-West Provinces and Oudh,—No. 366—C.-VII, dated Naini Tal, the 30th June 1897.*

Report of Director, Land Records and Agriculture, N.-W. P.

Under the instructions of Government, I have the honour to submit a report on the results obtained with the carrot seed imported from Europe into these Provinces in November and December last. As I did not take over charge of this Department till 23rd April 1897, I have no personal knowledge of the earlier history of the experiment. But the memoranda left by Mr. Moreland, and the reports of District Officers, are supplemented by two full notes prepared by Saiyid Muhammad Hadi, Assistant Director of this Department, and herewith enclosed in original. The great bulk of the work in connection with distributing the seed, keeping the accounts of advances made, and tabulating and testing the results obtained, has fallen on that officer; and I trust Government will recognise the industry, care, and skill he has displayed throughout.

I.—Preliminary.

Scarcity of 1896.

2. When the weak monsoon of 1896 made the grave failure of the Autumn crops a certainty and raised serious anxiety as to the prospects for the spring harvest, the attention of Government turned to the advantages of quick-growing root crops as an auxiliary source of food-supply. It was recognised that the period of greatest distress would be the months preceding the ripening of the spring harvest, when the Autumn cereals would have become largely exhausted and prices would be at their highest. During this period, carrots are among the most prominent of the food-staples in ordinary use.

They are sown in late September or early October, come into the market by the 1st of March, and play an important part in supporting the poorer classes till harvesting operations begin.

Extension of carrot cultivation.

3. To encourage and make possible a large extension of the area usually devoted to carrots was therefore felt to be a proper and fitting expedient in the scheme of famine relief; and it was determined to supply large quantities of seed as State agricultural advances wherever cultivators could be induced to sow it. But the amount of seed available in the Indian market fell far short of the indents submitted by District Officers. The carrot is grown almost entirely by the specially skilful castes that practise garden cultivation: there is no demand for seed among the ordinary agricultural classes, and consequently the growers keep little more than is required for their own individual fields. The total amount that Government succeeded in purchasing in the country was somewhat under 40 maunds, or about 1½ tons—utterly insufficient for the requirements of the Provinces. Time was pressing, and an appeal had to be made to foreign markets. Expert gardeners gave their opinion that it was still possible to import European seed and grow it with success. The India Office in England was communicated with by telegram, and with all possible despatch two large consignments of carrot seed were shipped off from London and Marseilles in the end of October and beginning of November.

Local supply insufficient.

4. The agents employed by the India Office for the collection and forwarding of the seed were Messrs. Carter & Co, and according to their invoices the quantity despatched and the value of the freights were as below —

Quantity and value of imported seed.

Shipment.	Weight.				Value.			Despatched by—
	Tons.	cwt.	qrs.	lb	£	s.	d	
First	10	0	0	0	750	0	0	S.S. *Peninsular* at London.
Second	14	0	0	0	1,000	0	0	
Third	47	9	1	21	2,998	14	5	S.S. *Himalaya* at London.
Fourth	35	14	1	7	2,440	10	3	S.S. *Peninsular* at Marseilles.
Supplementary	0	2	0	0	6	17	6	S.S. *Himalaya* at London.
TOTAL	107	5	3	0	7,196	2	2	

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Condition of seed as despatched.

The seed was of three distinct varieties—large white Mediterranean, large yellow Mediterranean, and large red Mediterranean. A portion of each consignment was cleaned before despatch, but there was no time to clean all the seed, and about 41 per cent. of the total amount reached us uncleaned. The quantities of the different classes of seed as invoiced by Messrs. Carter & Co., are given below:—

Kind of seed.		Tons	cwt.	qrs.	lb
White	Cleaned	38	15	3	16
	Uncleaned	18	4	2	1
Yellow	Cleaned	2	1	0	0
	Uncleaned	7	13	0	24
Red	Cleaned	20	16	2	10
	Uncleaned	18	13	2	5
Mixed	Cleaned	1	1	0	0
TOTAL	Cleaned	62	14	1	26
	Uncleaned	44	11	1	2
GRAND TOTAL		107	5	3	0

Price.

The price charged on cleaned seed for the first shipment was £75 a ton, raised in the subsequent shipments to £80; for uncleaned seed it was £50 a ton.

Packing.

5. The seed was all packed tightly in sacks. In the majority of cases the original bag was sewn into an outer covering of stout sackcloth, but in a number of the bags despatched from Marseilles the double covering had to be dispensed with through pressure of time. The protection afforded by the outer sack was considerable; but none of the bags could have been perfectly air-tight or immune from injury in transit. One of the bags in the first consignment, indeed, was so damaged at the London Docks that Messrs. Carter had to send out another one to replace it.

II.—Arrival and Distribution of the Seed.

6. The first shipment (59[illegible] tons) of the carrot seed, brought by the S.S. *Peninsular*, reached Cawnpur on 29th November 1896. The season was already far advanced; every day was valuable; and [illegible] imperative that the seed should be at once distributed to the [illegible] it. By previous arrangements made with the districts [illegible]

Distribution in India.

railway authorities this was effected, and the whole consignment was broken up and despatched to different districts by the evening of the day on which it had arrived There was, of course, no time to weigh it; and the Department had up to then no intimation that the bags contained different varieties of seeds, as it was not till a week later that Mr. Moreland received the Government of India's letter forwarding details of the consignment. The District Officers to whom the seed had been despatched were subsequently asked to weigh the amount received by them, and to distinguish the quantity of the different varieties in their allotment. But in many cases the seed had been mixed and partly distributed before this could be done; and to that account may be laid certain discrepancies in weight which will be mentioned hereafter, and also the scanty information which comes from many districts as to the relative success of the several varieties of carrot grown.

Second shipment.

7. The second shipment ($47\frac{1}{2}$ tons), *ex* S.S. *Himalaya*, arrived at Cawnpur on 6th December 1896. The varieties it contained were by this time known, and specimens of each kind of seed were retained for experiments in the Cawnpur Farm. The bulk of the remaining seed was despatched to make up the original indents received from districts, and should have reached the Collectors concerned by 15th December at the latest. (In Bahraich, however, it did not arrive till 19th December.)

Further distribution.

8. It is unnecessary to tabulate the total amount of seed despatched to each district Causes, which will be discussed further on, interfered with the full utilization of the seed provided, and large quantities were returned to our granaries at Cawnpur. The amount of seed, however, actually distributed by District Officers is shown in the attached table.* There has been some delay in getting the accounts cleared up, and I am unable at present to locate exactly the small quantity of country seed which was dispensed before Messrs. Carter's consignments arrived. It has accordingly been included in the statement, into which it imports a negligible error of only about 2 per cent., and the districts supplied with country seed have been printed in italics.

Price of seed.

The prices at which Government has directed the seed advances to be credited in the accounts are R50 per maund of cleaned, and

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Areas sown.

tity of seed employed, we get 8,230 acres as a rough estimate of the provincial area devoted to the experiment Had the result of the sowings been more successful, an attempt would have been made to ascertain more accurate figures of acreage. But as matters stand, it has not been thought proper to ask District Officers for statistics which would be of little practical value; all that has been asked of them is an estimate of the area on which the crop has failed, with a view to recommending remission of the price with which the cultivators who have suffered have been debited.

IV.—Germination and Treatment of the Crop.

Treatment of the crop.

11. Ideal treatment for the imported seed would have been to put it into good loose soil which had been carefully tilled beforehand to a considerable depth and fertilized by old manure, to sow it in rows, to weed out the plants after germination at several inches interval, and to water from six to eight times between germination and maturity. In the case of the uncleaned seed, it was further strongly recommended that a free mixture of wood ashes should be added before sowing. The actual treatment accorded to the seed was, it is believed, in most cases very different The seed arrived at a time when all the rich garden land had been taken up by other vegetables and high cultivation. The necessities of the season had concentrated the winter cereals on the best available soil. If outlying lands had been abandoned, every acre within reach of well or canal irrigation had been occupied; and all the old manure in the villages had been used up for the wheat and cane fields. The carrots had thus to take their chance on mostly inferior soil; manure, if given at all, was generally fresh and over-rich; and water could with difficulty and only occasionally be spared for them. The sowings were, moreover, invariably broadcast, and weeding was, according to the country custom, sparingly practised. The admixture of wood ashes was duly enjoined on the cultivators after instructions to that effect arrived from the exporters; but it was a new idea to most of them and was by no means zealously adopted.

Broadcast sowing.

Germination slow.

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R35 per maund of uncleaned, seed, equivalent to R1-4-0 and 14 annas per *ser*, respectively.

Dates of sowing and areas sown.

III.—Dates of Sowing and Area Sown.

9. On the arrival of the imported seed, sowings were begun with creditable promptitude. It necessarily occupied some little time to have the supply registered, allotted to tahsils, sent out and put in the hands of cultivators. But in the Sahâranpur, Pilibhît, Fatehpur, Allahabad, Jhánsi, Benares, Basti, and Bara Banki districts the great bulk of the seed advanced was got into the ground by the end of December. In most of the other districts sowings were over by the middle of January, but in a few scattered cases seed was sown as late as the end of February. General distrust was expressed of the utility of putting down seed after Christmas; but, as the Collector of Allahabad has pointed out, the intercalary month of the Hindu year deluded the cultivators into sowing up to a later date by our calendar than they would otherwise have done.

10. Figures for the area sown are not available. The area under carrots is not extracted separately from that under other garden crops in the *patwáris*' annual papers, and no special survey and record of the imported carrot seed sowings seem to have attempted. In distressed districts the *patwáris* were actively employed in connection with famine relief work, and in other tracts they had partly got through their *rabi* inspection tours before the seed was sown.

Hardoi

Partabgarh.

Cawnpur.

The rough estimate made by several District Officers does not go far to take the place of accurate figures. In Hardoi, for instance, 1,533 acres are reported as having been sown with the seed distributed, which was about 95¾ maunds in amount; while in Partábgarh 34¾ maunds are shown as having served 89 acres. In the Cawnpur Farm experiments the allowance of seed per acre was 12 and 18lb for cleaned and uncleaned seed respectively; but, according to the above figures, it averaged barely 5lb in Hardoi and ran up to 32lb in Partabgarh.

As announced by several District Officers, a certain quantity of the later received seed was held over for planting next season by the cultivators to whom it was advanced. Thus, out of the 1,719 maunds distributed, probably not more than 1,500 maunds were put into the ground. And, if we take 15lb per acre as the average quan-

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Outturn.

15. But this did not exhaust the misfortunes of the harvest. For the quality of the roots obtained was markedly inferior. That they would be individually less bulky than the large and fibrous native variety of carrot was of course expected. But what they wanted in size they failed to make up in succulence. Exceptionally deficient in length and girth, they were also hard and bitter, as a rule unpalatable, and in several districts uneatable except by cattle. As the season wore on and the air and soil got drier, the complaints of bitterness increased, and the later harvested carrots were almost entirely used as fodder. The best carrots that I saw at Cawnpur were distinctly unpleasing to the taste, and the most charitable account given of them is Mr. Brownrigg's, in an interesting statement of his own private experiments, where he describes them as mistaken for fairly good parsnips.

Yield of carrots from country seed.

16. In ordinary circumstances the addition to the food-supply from carrot cultivation might reasonably have been anticipated at 200 *maunds per acre. Country* seeds sown at Cawnpur in October gave a yield of from 200 to close on 500 maunds; and in Sahâranpur, from comparatively late November sowings, 50 maunds an acre were secured. The results from the imported seed must, therefore, be taken as having almost everywhere disappointed the hopes entertained of it and failed of the purpose for which it was advanced. How far the failure was due to negligent cultivation, and how far to other causes, may now be examined, the test applied being the comparative results in Cawnpur

VI.—The Cawnpur Experiment and a Summary of the Provincial Results.

Cawnpur experiments.

17. The experimental cultivation from the imported seed was conducted under the immediate orders and supervision of Saiyid Muhammad Hadi, the Assistant Director of this Department and a distinguished agriculturist.

Character of soil, etc.

18. The soil of the experimental plots is throughout good, friable loam (*dûmat*), adjoining and abutting on the naturally manured zone (*gauhan*) of one of the Cawnpur suburbs. It has every advantage of canal irrigation, careful tillage, and sufficient manure The climate is hot and dry, typical of the Lower Doab, and there was next to no frost, even in the midwinter nights.

Treatment of crop.

of districts, fair to good, except in the case of uncleaned seed, with which the special precautions prescribed had been frequently omitted. The sprouting of the seed was in some cases hastened by soaking it in water or milk before sowing; but my own experience of this method is that, as a preliminary to cultivation in richly manured soil, it is fatal to the after-growth of the plants. The complaints from several districts of the total or partial failure of germination are probably due in part, as surmised by the Assistant Director, to weakness in the uncleaned seed and to unskilful treatment of it. But in many cases the lack of vitality must also be attributed to the seed having been put into hard baked soil, which had been imperfectly prepared for it and was deficient in natural moisture. The theory of inherent flaws in the seed, which would have definitely debarred germination under conditions howsoever favourable, will be discussed in a later part of this report.

V.—Harvesting and Outturn.

Harvesting

13. With late sowings, slow germination, and in most places a scanty supply of water to stimulate growth, the carrot harvest was naturally much delayed. Instead of maturing, as country seed sown at the ordinary time would have done, in early March, the crop was hardly anywhere fit for digging till the last week in April, and in many places it was not taken up till the first half of May.

14. The figures of outturn in different districts vary greatly and contain little information of any value as to the comparative success of the different varieties of carrot grown. Appendix B* gives an abstract of the reports received from District Officers, and indicates broadly the general character of the harvest. The information of the reports can fortunately be supplemented by a number of differential experiments made at Cawnpur; and a summary of the results must be deferred till these experiments are discussed. At present it will suffice to note that, in the hands of the ordinary cultivator, the outturn (with two abnormal exceptions in Allahabad and Mainpuri) is nowhere known to have exceeded 40 maunds an acre. In the majority of cases the produce did not come up to 10 maunds; and in more than half the reporting districts the crop was either insignificant or entirely lost

Average outturn.

* Not reproduced.

Outturn.

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Cawnpur experiments.

19. There were eight experimental blocks, sown in succession from the end of November till the beginning of February, and all treated in different ways. A brief account of each is appended :—

No. 1.—Sown (from the first consignment) on 30th November 1896. No manure. Two weedings and nine waterings. Germinated in two weeks. Harvested in first days of May *Outturn 51 maunds an acre (with white cleaned* seed only).

No. 2.—Sown 7th December 1896 with seed of all six varieties, No manure, but richer soil than No. 1. Two weedings and eight waterings. Germinated in three weeks. Harvested on 27th April 1897. Outturn—for uncleaned seed below 24 maunds; for white yellow, and red cleaned. 64 maunds, 74½ maunds and 37 maunds, respectively.

No. 3.—Sown on 17th December 1896 with all six varieties and in three different methods. Two weedings and six waterings. Rich naturally manured soil. Germinated in a fortnight. *Harvested in last week of April.* Broadcast sowings a failure except with red uncleaned seed (66 maunds). Sown in drills, white and yellow uncleaned seed failed, but all red seed did well (76 to 81 maunds), and white cleaned gave 109 maunds; sown on ridges, the results were similar, but yellow cleaned gave 136 maunds. These were the best results in the whole series of experiments.

No. 4.—Sown on 20th December 1896 with all six varieties. Manured with poudrette; one weeding and five waterings. *Harvested in last week of April. White and yellow uncleaned seed a failure; red seed, about 31* maunds white cleaned, 60¾ maunds per acre.

No. 5.—Sown on 25th December 1896 and treated exactly like No. 4. Harvested 19th to 22nd April. Uncleaned white and yellow seed failed; red seed, 39 maunds (cleaned) to 60 maunds (uncleaned); cleaned white and yellow, 49 and 59 maunds, respectively.

No. 6.—Sown on 31st December 1896 with cleaned seed only. Treated like Nos. 4 and 5. Harvested 30th April 1897. Outturn nowhere up to 24 maunds.

at Seasons of Threatened Scarcity or Famine. | DAUCUS Carota.

No. 7.—Sown on 24th December 1896 and 4th January 1897 with cleaned seed only. Treated in every way as a native cultivator would have worked. Harvested 2nd May. Outturn nowhere up to four maunds an acre.

No 8.—Sown on 12th January 1897 on manured land. Not harvested, as roots thin, hard, and unfit for food.

Cawnpur experiments.

20. Experiments Nos. 3 and 7 are the most interesting of the series. No. 3 shows the importance of cultivating the carrot on the rich circum-hamlet zone (*gauhan*), which is the natural habitat of garden crops It illustrates also the superiority of sowings in drills and on ridges to the native method of broadcast sowing, which was adopted in all the other experiments. No 7, on the other hand, exhibits the true indigenous conservative methods The land was old fallow, such as the cultivator might have selected after all his best land had been occupied by *rabi* crops. The seed was sown broadcast. The country plough and field hoe were used. Irrigation was given from a well four times, being about as often as the ordinary cultivator could afford water. And a liberal, but injudicious, supply of cow-dung manure was provided, being the best the ordinary cultivator would have done for the crop. The sowing took place about the time at which most of the imported seed throughout the provinces was laid down, and the crop was dug up in early May. The outturn did not exceed four maunds an acre, if the seed had not been badly choked by weeds, it might have yielded up to 10 maunds.

Broadcast sowing.

Irrigation

Manure.

Yield.

21 The average outturn of the various types of seed in the first seven plots is quoted in Part (*b*) of Appendix C.* The striking inferiority of the uncleaned seed of the white and yellow varieties led the Assistant Director to consult the Botanical Department, and I have just received from Mr. Gollan an interesting note of a test applied by him at Mussoorie He put down 200 seeds of each variety in pots during the current month, and up to 25th instant the germination had been—

Mr. Gollan's germination tests.

White, cleaned	63 plants.
,, uncleaned	3 ,,
Yellow, cleaned	114 ,,
,, uncleaned	*Nil*
Red, uncleaned	113 plants

* Not reproduced.

DAUCUS Carota.	Carrot cultivation as an Emergent crop

Cawnpur experiments

19. There were eight experimental blocks, sown in succession from the end of November till the beginning of February, and all treated in different ways. A brief account of each is appended :—

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* Not reproduced.

DAUCUS Carota.

Carrot Cultivation as an Emergent Crop

Causes of failure.

propose briefly to discuss. The probable causes of failure may be classed under four heads:

(*a*) the quality of the seed;
(*b*) the unwillingness of the people to use it;
(*c*) the time of sowing; and
(*d*) the conditions of cultivation.

General results.

27. (*a*) There is a general and clear consensus of opinion that the uncleaned seed of the white and yellow varieties was distinctly inferior. It was given every advantage of skilful cultivation at Cawnpur, and its results were in striking contrast to those given by cleaned seed of the same varieties as well as by the uncleaned red seed. At the risk of repetition, the Assistant Director's figures are quoted below to enforce the comparison:—

Kind of seed.		Produce in maunds on plot No.—						REMARKS.
		II.	IIIa.	IIIb.	IIIc.	IV.	V.	
White	Cleaned	64¾	27	109	72¾	60¾	49	
	Uncleaned	23½	2	12	23¾	8	8	
Yellow	Cleaned	74¾	21	74½	136	29	59	
	Uncleaned	20¼	1	11¼	24¼	10¾	4	
Red	Uncleaned	23½	66¾	76	51¼	30¾	60	

The result of the germination trial made by Mr. Gollan at Mussoorie is further evidence of the want of vitality in the uncleaned white and yellow seed. The Assistant Director, in Part VIII of his General Note, gives his reasons for considering that the bags of uncleaned white and yellow contained a large proportion of immature seed, taken in all probability from the lateral shoots of the carrot plant, gathered prematurely and incapable of germination.

Immature seed imported.

The Assistant Director conjectures that the large and sudden demand for seed may have led to considerable crops of seed carrots being cut and threshed, ripe and unripe together. From the c[illegible] spondence with the India Office it would appear that Messrs C[illegible] & Co. had not entirely completed their purchases before the G[illegible] ment of India came into the market: and it is just probable th[illegible] maturity of the white and yellow uncleaned seed (which came [illegible] in the second shipload and largely from Mars[illegible]) been fully tested before despatch.

It was hoped that a microscopical examination [illegible] seed elicit the cause of defective germination, and [illegible] means

General Results.

different varieties were accordingly submitted to Mr. Duthie, Director of the Botanical Department, Northern India. Mr. Duthie has, however, been unable to detect any difference in the structure and condition of the individual specimens sent to him · and he has written to say that he considers germination trials to be the only true test of the vitality of the seed.

As both in these trials and in the actual outturn the white and yellow uncleaned seed has done extremely badly, it now only remains to suggest that Government should move the India Office to ascertain from their agents the probable cause of the failure of those particular varieties.

Carrot seed not hardy.

28 That the seed generally suffered by being despatched to India in sacks instead of in hermetically sealed cases is a theory that has been advanced from several quarters. It was broached in an editorial note in the March issue of *The Indian Agriculturist* (page 71); it has been alluded to by Mr Duthie as a probable cause of bad germination; and it has been suggested by several District Officers Carrot seed is notoriously delicate, and every precaution is taken by private seeds-men to protect it from air and damp. That the sea voyage was injurious to it, packed as it was, is therefore an intrinsically probable theory; but there is no evidence to support it. The seed, as far as we can gather, lost weight by shrinkage on the journey from Europe to Cawnpur; if it had suffered by sea voyage, it would probably have absorbed moisture and gained weight. It looked fresh and sound when the bags were opened ; and the germination of the cleaned (and red uncleaned) seed was everywhere satisfactory, arguing against the theory of any extensive damage in transit. But even supposing the evidence had gone the other way, it is questionable whether responsibility for the damage would have attached to the consignors. Any attempt to hermetically seal 108 tons must have meant a delay in shipment that would necessarily have been fatal to the whole scheme.

Seed not appreciated by cultivators.

29. (*b*) The unwillingness of the people to take the seed is complained of by several District Officers, and resulted in more than a third of the quantity indented for being returned upon our hands. This attitude was the product of various causes The delay in receiving the seed was the chief of them; the cultivator has little regard for expert opinion and was satisfied that seed sown six weeks

DAUCUS Carota.

Carrot Cultivation as an Emergent Crop

General Results.

after the normal date was doomed to failure. The price of the seed was grumbled at; *four annas a ser had been in ordinary years the* bazar rate for country seed, and though last year it had run up to 12 annas and over, and then disappeared from the market altogether, the cultivator haggled against the rates of advance offered by Government. Then, again, the use of European carrot seed was a novelty: and with the poorer classes *ignoti nulla cupido* is truer than ever in a famine year. And, finally, in one district (Ghazipur) the Collector found religious objections urged against the experiment, though their nature is not stated.

Delay in sowing.

30. (*c*) Delay in planting the seed was after all what handicapped the scheme most severely. That the people were willing enough to extend their sowings at the usual season is manifest; estimates from several districts show that the area in country carrots in 1896 was very greatly above the normal, and the results were evidently successful. That imported seed, if available in October, would have been readily taken up and grown with fair success can scarcely be questioned. From our Cawnpur experiments it is apparent that the English seed, planted even up to 20th December on suitable soil, gave reasonably good returns and would have materially supplemented the food-supply, though it could scarcely have been brought on the market before the *rabi* harvest. But every day of delay after the middle of December meant a dwindling outturn and deterioration in the quality of the roots. And delay to some extent was inevitable. It was not till the first half of the month that the consignments reached District Officers, and the distribution was hampered by the backwardness of cultivators to apply for it.

Untimeliness of the season.

The late dates of sowing had other effects than the mere untimeliness of the season. Long before December, the land usually devoted to garden cultivation had been occupied, and every effort had been strained to put all the best outlying soil under *rabi* crops. Tillage was concentrated round all the available sources of irrigation: and fallows in good land meant the powerlessness of the cultivator to work it, come his seed whence it may. The carrot required rich natural soil and free irrigation: and by the time seed could be imported, those conditions were in very many cases unattainable. When the seed was eventually put down, all the scanty moisture left by the monsoon had evaporated. And ere it germinated, the dryness of the

General Results.

air and hardness of the soil were not to be counteracted by artificial irrigation. To these causes was due the hard and bitter quality of the roots when they came to maturity.

31. (*d*) In the matter of careful and intelligent cultivation, the imported seed did not in many places get a fair chance. That any skill of tillage would have saved the late sown seed, especially in the eastern part of the provinces, seems doubtful, as witness the experiments made by Mr. Bird at Muttra, Mr. Browrrigg at Sultanpur, and Mr. Cobb at Benares. But individual instances of successful work under favourable conditions are noted by the Assistant Director. Improved methods at Cawnpur gave reasonably good results: and the intelligent cultivators of the Doab showed that a fair outturn was possible. The fact remains, however, that in the hands of the ordinary cultivator, unpractised in market gardening, indigenous systems of treatment are apt to fail with the delicate seed of the European carrot. The sowings are made broadcast on level plots, while ridge and furrow sowings are essential to success. Weeding is rarely employed, however thickly the plants may germinate: the cultivator shrinks from the seeming waste of freely thinning his field, and substitutes a process of shaving off the leaves, which only tends to toughen the roots. Manure, if applied, is generally fresh and over-rich, causing the "forking" deformity to appear in the carrot; and irrigation is not always judiciously regulated.

Vegetable cultivators *versus* common husbandmen

With the special castes that practise vegetable cultivation, the treatment, if similar in its general lines, is more careful and successful. If our imported seed had found its way entirely into their hands and got a place in their small, highly tilled holdings, the results would have been very different from what they are. As it is, the seed was largely taken up by ignorant husbandmen, who had to work it by primitive methods and mostly on inferior, outlying and imperfectly irrigable soil. To this were added the disadvantages of a particularly inclement season and a certain indifference among the cultivators as to the success of the experiment.

32. To the above summary of the causes that have interfered with the success on this occasion of European carrots as a famine food, there is little to be added. It may reasonably be concluded that imported seed—by preference of the large red Mediterranean variety—will succeed quite as well as country seed if put into the

Red Mediterranean the better variety.

General Results.

hands of skilful cultivators by October. If the right classes of husbandmen get the seed, with simple directions as to its treatment, they will almost certainly be able to put a larger supply of food on the market than the gross amount which the general cultivator could raise for himself on his own land by indigenous methods: and should, unfortunately, the necessity again arise for the experiment, it is hoped that, with the knowledge now acquired, this Department will be able to give effectual assistance in executing the intentions of Government.

Further Information asked for.

The Government of the North-West Provinces in acknowledging the above report requested that further information might be furnished on the following points:—

(1) the amount of seed actually planted before the end of November, and the weight and character of roots harvested;

(2) the amount actually planted before December 10th, and the weight and character of roots harvested;

(3) the amount planted up to the end of December, and the weight and character of roots harvested;

(4) the amount planted after the end of December, and the amount and character of roots harvested.

The Director after referring to the reports of the District Officers reviewed the returns under the following heads (1) The area sown; (2) The quantity of seed sown per acre; (3) Dates of sowing; (4) Outturn. From these statistics the following statement was prepared which afforded an approximate answer to the questions in the Government Order:—

Amount of seed planted.

Character of roots harvested.

(1) The amount of seed planted before the end of November—*nil.*

(2) The amount of seed planted before December 10th—230 maunds. The weight of roots harvested therefrom—25,095 maunds. The character of the roots—about 3,000 maunds fairly edible, though thin and defective in girth; the remainder edible, but bitter and unpleasant to the taste.

(3) The amount of seed planted from 11th to 31st December—562 maunds. The weight of roots harvested therefrom—42,745 maunds. The character of the roots—about 10,000 maunds still edible, but hard, thin, pungent and with a coarse, fibrous core occupying the most of their bulk; the remainder coarse and unfitted for human food.

Character of roots.

(4) The amount of seed planted after 31st December—608 maunds. The weight of roots harvested therefrom—6,870 maunds. Acrid and uneatable, except by cattle.

The Director's interesting remarks on the character of the roots harvested indicate a considerable disparity between them and the well-known vegetable as ordinarily supplied by market gardeners. "According to the unanimous opinion of all the District Officers the carrots grown from seed sown after Christmas were hard, thin, and completely unpalatable, fit only for feeding cattle upon. Those grown from seed planted in the earlier part of December were small and bitter: at their best they were stringy, with a fibrous, inedible core and a taste like indifferent parsnips. Their succulence, too, varied according to the class of seed, the red variety being fairly sweet and the white invariably coarse. It differed, too, with the soil and place of growth, the plants, for instance, on the ridges along irrigation channels being juicier and fleshier than elsewhere. In the Cawnpur Farm I saw some edible carrots of fairly normal size, and in Basti I was informed that the carrots were eaten with approval; but all the carrots I got in Bareilly and Lucknow were in length and girth like a lead pencil, and in taste acrid and repellant. It is thus impossible to generalize as to the character of the roots grown at particular times."

Chemical analyses of carrots.

The following analyses of two samples of carrots (white and red) grown on the *usar* land, Gursikram and Aligarh, during the *rabi* season 1896-97 were made by Dr. J. W. Leather, Agricultural Chemist to the Government of India. By the side is placed the report of an analysis of carrot root given in *Cooley's Cyclopædia*, 1892. The composition of the roots grown in India and in England does not exhibit much variation.

	White carrots.	Red. carrots.	English carrots.
Water	84·57	84·43	87·30
Soluble albuminoids	·35	·48	·66 (both albuminoids)
Insoluble ,,	·17	·30	
Sugar, starch, etc.	8·98	7·98	8·10
Crude fibre	2·37	3·70	3·20 (both fibre)
Woody ,,	2·19	1·80	
Soluble mineral matter	1·09	·99	·74 (both mineral matter)
Insoluble ,,	·28	·32	
Total	100·00	100·00	100·00
Total Nitrogen	·175	·230	

General Results.

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tive, and if they are left over till November, their yield is, under ordinary conditions, of little or no value.

Conclusions from Cawnpur experiments.

(*b*) The crop requires to be irrigated and fairly plentifully manured. At the Farm, where our best results were obtained, six to nine waterings were given between germination and maturity, and manure was provided at the rate of 200 maunds per acre. On unmanured land the outturn was exceedingly poor, and last year's experiences proved the futility of trying to grow the crop without irrigation. Sowings on ridges met, on the whole, with better success than the ordinary country method of broadcast sowing, though on poor soil and with defective irrigation the superiority would apparently disappear. The general conclusion to be drawn from the experiments is that the *cultivation of imported carrot seed is more suitable for the* minute skill of the market gardening classes than for the broader style of work displayed by the ordinary cultivator. This is of course nothing new; but it may be taken as a recommendation against advancing carrot seed to a cultivator in future, unless he can guarantee manured soil, irrigation, and reasonable care for its tillage.

Irrigation and manure necessary.

(*c*) A comparison of the results obtained from the different varieties of seed received from Europe places it beyond doubt that the uncleaned seed, on the whole, was markedly defective in germinating power. This fact, when stated in previous reports, was questioned by Messrs. Carter & Co.; but we have made it the subject of most careful trials and observations, and we are fully confirmed in the conclusions formerly expressed. Last year we found the red uncleaned variety to possess reasonable vitality, but the white and yellow uncleaned seed gave almost uniformly bad yields. This year they have still further deteriorated, and their outturn has been almost negligible. Without any discussion as to the cause of this phenomenon, it may be safely recommended that in future no seed be imported unless the dealers are able to clean it before despatch and to guarantee it mature.

Cleaned and matured seed only to be sown.

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Editor, Dr. George Watt, Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series; those on Forestry in the Forest Series. Papers of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

This sheet and the title-page may be removed when the subject-matter is filed in its proper place, according to the letter and number shown at the bottom of each page.

NOTICE.

Future issues of this publication placed under either the "Special Veterinary" or "Special Forest Series" will not be included in the annual enumeration. Such papers are printed for Departmental purposes. Their unfortunate inclusion in the system of annual numbering has led recipients of the ordinary issues to think their sets incomplete.

The following pamphlets have already appeared as Special issues, and have not accordingly been furnished to the public.

1894 . . . Nos. 8, 9, 10, 11, 13 and 15.

1896 . . . No. 8.

THE

AGRICULTURAL LEDGER.

1898—No. 14.

COAL.

(INDIAN COAL.)

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. II., C. 1414-41.*]

REPORT ON THE COAL SUPPLY OF INDIA.

Including results of the Examination of Selected Samples from the Principal Seams. (With Appendix containing Tables of Results.) By PROFESSOR WYNDHAM R. DUNSTAN, M.A., F.R.S., *Director of the Scientific Department of the Imperial Institute, London.*

Other PAPERS that may be consulted:

Imperial Institute Hand-book No. 9. Indian Coal.

The Agricultural Ledger No. 2 of 1895.



CALCUTTA:
OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING, INDIA.
1898.

Price 6 annas or 6d.

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(1) To provide information connected with agriculture or with economic products in a form which will admit of its ready transfer to ledgers;

(2) To secure the maintenance of uniform ledgers (on the plan of the Dictionary) *in all offices* concerned in agricultural subjects throughout India, so that references to ledger entries made in any report or publication may be readily utilised in all offices where ledgers are kept;

(3) To admit of the circulation, in convenient form, of information on any subject connected with agriculture or economic products to officials or other persons interested therein;

(4) To secure a connection between all papers of interest published on subjects relating to economic products and the official Dictionary of Economic Products. With this object the information published in these Ledgers will uniformly be given under the name and number of the Dictionary article which they more especially amplify. When the subject dealt with has not been taken up in the Dictionary, the position it very possibly would occupy in future issues of that work will be assigned to it.

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PREFATORY NOTE.

The valuable and interesting report by Professor W. R. Dunstan, F.R.S., reproduced in these pages may be fittingly preceded by the following brief account of the manner in which the present inquiry originated.

In 1895 Sir F. A. Abel, Bart. K.C.B., Secretary and Director, Imperial Institute, forwarded to the Government of India in the Revenue and Agricultural Department a report upon the specimens of coal transmitted by the Department for exhibition in the Indian Section of the Imperial Institute and for the purposes of examination. The report included the results of the technical examination in the Research Department of the Institute of the whole of the samples and of the elementary analyses of those which were shown by that examination to be of superior quality.

Conf. p. 5.

In Sir F. A Abel's letter on the subject, Flying Seal Series No. 42, dated 7th March, the following paragraph occurs :—

" In no instance was the sample received sufficiently large to permit of practical experiments, with a view to the determination of the calorific value, etc. Should experiments of this kind be desired in any particular instance, they can be carried out in the Research Department, provided one or two cwts. of the coal to be thus examined is forwarded."

PREFATORY NOTE.

On the case being transferred to the Reporter on Economic Products for further action, those firms who had previously supplied samples, and others were invited to furnish about two cwts. of coal from their respective collieries for ascertaining the calorific value and chemical composition. A reminder was subsequently issued to the Managers and Proprietors of the collieries which had not responded to the original circular pointing out that the collection of samples already to hand was of so representative a character that it seemed undesirable that any collieries should be omitted.

The second larger series of samples now reported on form the result of that correspondence.

It may be mentioned here that out of 45 companies and individuals addressed, 28 furnished samples, and only 17 either did not reply (12) or declined to avail themselves of the offer placed before them (5).

Conf. pp. 22, 24 et seq.

It may also be well to explain that the numbers quoted in Table II., column 1, and there described as Indian Invoice numbers are in reality the Indian Museum Registration numbers. Smaller duplicates of the samples furnished to the Imperial Institute were in every case retained in the Indian Museum both for purposes of verification and in accordance with the standing rule which provides that for every specimen despatched to the Imperial Institute an exact duplicate shall be retained in the Indian Museum. The advantages of this procedure are obvious. A London firm is thus enabled to communicate with its Calcutta correspondent, or *vice versa*, referring him to a sample exhibited in both the Imperial Institute and the Indian Museum under one and the same registration number.

It need only be remarked that the Director's report on the coal supply of India together with the table of analytical results are printed in their entirety. The portion of the appendix containing the diagrammatic arrangement of the chemical analyses and the specially prepared map of India are not, however, reproduced. The only addition is that made to Table I, where the statement giving the outturn of the collieries for 1896 is brought up to date by inserting the official returns for 1897.

Conf. p. 21.

Introductory.

At the instance of the Government of India an examination has been made in the Scientific Department of the Imperial Institute of

INTRODUCTORY.

a number of large samples of coal taken from some of the principal seams in India, many of which have not been previously examined. The coals were collected under the supervision of Dr. George Watt, C.I.E., the Reporter of Economic Products to the Indian Government. Two series of samples have been received. The first series formed the subject of a report from the Scientific Department in 1895, which has been printed in the Indian "Agricultural Ledger," No. 2, of that year (*see also* "Imperial Institute Journal," Vol. 1, No. 4, p. 162, and "Annual Report of the Indian Committee of the Imperial Institute," India Office, 1897). The results of the analysis of this first and smaller series are, for convenience of reference, included in the table appended to this Report, being marked by an asterisk. The second, larger, and more representative series forms the chief subject of the present Report.

Conf. p. 1.

Conf. pp. 22, 23 et seq.

Literature.

Bibliography of Indian Coal.

In addition to the Report above-mentioned, the following works are of importance in connection with the history, occurrence, distribution, production, composition, and characteristics of Indian coal:—"Memoirs of the Geological Survey of India," 1871-97, papers by T. W. H. Hughes, F. R. Mallet, W. King, F. Noetling, T. De la Touche, P. N. Bose, etc.; Ball's "Geology of India," Vol. III., 1881; Watt's "Dictionary of the Economic Products of India," article "Coal," by Dr. W. Saise, Manager of the East Indian Railway Collieries, "The Karharbari Coalfield, with some remarks on Indian Coals," by Dr. W. Saise; "Proceedings of the North of England Institute of Mining and Mechanical Engineers," 1880; "Annual Review of Mineral Production in India" for 1896 by Dr. George Watt, C.I.E., Calcutta, 1897; "Imperial Institute Series of Hand-books of Indian Commercial Products, No. 9, Indian Coal," Calcutta, and Imperial Institute, London, 1893.

It will be convenient to briefly summarise here the chief points in connection with the occurrence, distribution, production and characters of Indian coal.

Occurrence.

Age of Indian Coal measures.

From the exhaustive investigations made by the Geological Survey of India, it appears that the Indian coal measures belong, not like those in England and Wales, to the carboniferous period,

OCCURRENCE.

but chiefly to the upper palæozoic and lower jurassic formations. The coal occurring in the Peninsula, south of the Indo-Gangetic plains, belongs to the lower Gondwana period, whilst the extra-peninsular coal, *e.g.*, that of Assam and Upper Burma, is principally cretaceous and tertiary. This difference in the occurrence of coal in India and Great Britain is important in accounting for many of the peculiarities in the composition and characters of Indian coal as compared with English and Welsh coal.

Distribution.

Exploration of Indian coal-fields not complete.

Coal is widely distributed throughout India, except in Bombay and Sind, the North-West Provinces and Oudh, Rajputana, and Mysore, where the mineral is either scantily distributed or entirely absent. Many of the coal-fields have not been fully explored and only a small proportion of the total known coal area is at present worked. The seams in Bengal and Assam are frequently from 50 and 80, to as much as 180, feet in thickness. The pits are often of considerable depth; at present the deepest appears to be about 700 feet. In many cases the working of the seams leads to the escape of little or no fire-damp, so that the miners are able to work with naked lights. In 1895, 235 collieries were at work, but in 1896 only 172 were in active operation. At the present time Bengal produces more than three-fourths of the coal mined in India. The localities and extent of the local production in India may be learned from the following summary, taken from the last published returns (1895 and 1896). The chief coal localities are figured (roughly to scale) in the map* which is appended to this Report. This map is one prepared for the "Hand-book" at the instance of the Indian Government in 1892. The principal railways, which are marked, are important in connection with the question of transport.

Frequent absence of fire-damp. *Conf. p. 10.*

Over three-fourths Indian Coal furnished by Bengal.

Assam Coal Mines.

ASSAM.—The mines in Dufla, Khasi and Jaintia Hills, the latter including the Cherrapunji mines, the Garo and Naga Hills, and the district of Lakhimpur, in which the extensive mines of Makum occur, are of considerable importance in relation to the railway extension in this Province. The thick seams of the Makum mines are being actively worked, and are estimated to furnish 18,000,000

* Not reproduced.—*Ed.*

tons. In 1895, the production amounted to 172,717 tons; in 1896, to 177,259 tons. In these mines the boring is usually made horizontally into the hillside instead of by a vertical shaft.

DISTRIBUTION. Assam Mines Output.

Baluchistan Coal Mines.

BALUCHISTAN.—This Province produced 23,259 tons of coal in 1895, but only 10,572 tons in 1896, the chief mines being those of Khost and Quetta. Much of the coal is too friable to be of general use.

Bengal Coal Mines.

BENGAL.—In 1895 there were 218 collieries at work, producing 2,716,155 tons; in 1896, 154 collieries were worked, producing 3,037,920 tons, valued at R81,46,411. The principal fields are:—***Karharbari*** (200 miles from Calcutta), covering 8 square miles and estimated to contain 136 million tons; ***Raniganj-Barakar*** (about 130 miles from Calcutta), covering at least 500 square miles, and representing 14 thousand million tons; ***Jheria***, a few miles to the west of Raniganj, covering 200 square miles, and representing 465 million tons; ***Bokaro***, close to the Jheria field, which covers 220 square miles in thick seams estimated to contain 1,500 million tons; ***North Karanpura***, which occupies 472 square miles, representing 8,750 million tons; ***South Karanpura***, which represents about 75 million tons; ***Daltonganj***, covering 200 square miles, and representing about 11 million tons; ***Ramgarh***, a small field, south of Bokaro, occupying 40 square miles and representing about 5 million tons. Other fields, at present not largely drawn upon, are ***Talchir***, ***Rajmahal***, and ***Darjeeling***, where there is a narrow field of graphitic coal.

Burma Coal Mines.

BURMA.—The most important fields are the ***Thingadaw*** on the Irrawaddy, and those on the banks of the Chindwin river near Kalewa. The output of coal in Burma amounted to 17,239 tons in 1895, and to 22,993 tons in 1896.

Central India Coal Mines.

CENTRAL INDIA.—In 1895, Central India produced 98,219 tons of coal; in 1896, 115,386 tons The most important field, and the only one systematically worked, is that of ***Umaria*** in Rewah, which is only 34 miles from the Katni station on the East Indian Railway, and is therefore of great importance as a source of supply for the North-West Provinces and the Panjab. The Umaria field covers 3 square miles, and is computed to contain 28 million tons of coal. Other fields are those of ***Sohagpur***, close to Umaria, covering 1,600 square miles; ***Korar***, 9 square miles, and ***Bisrampur***, 400 square miles.

DISTRIBUTION. Central Provinces Coal Mines.

CENTRAL PROVINCES.—In 1895 the Central Provinces produced 122,776 tons of coal, but in previous years the amount was far greater. In 1896 it rose again to 141,185 tons. The principal mines are those of ***Mohpani***, on the Great Indian Peninsula Railway, about 100 miles to the south-west of Jabalpur, and ***Warora;*** the latter, which belongs to the Government, is responsible for the increased production of 1896. Other mines are those of ***Shahpur*** and ***Pench, Korba, Mand,*** and ***Rangarh;*** the three latter, which are in the Mahanadi valley, cover over 1,000 square miles and include several seams of great thickness.

Hyderabad Deccan Coal Mines

HYDERABAD.—The most important mine in Southern India is the ***Singareni***, in the Dominion of the Nizam. The output in 1895 was 292,915 tons; in 1896, 262,681 tons; most of it went to Madras and Bombay. The Singareni coal is of especial interest as being at present the nearest to the large deposits of iron ore of the Salem district, some of which is of excellent quality (*see* Annual Report of the Indian Committee of the Imperial Institute, India Office, 1897). Little is at present known of the large coal-fields of ***Kamarum, Cherla, Chinnur, Madavaram,*** and ***Beddadanol.***

Madras Coal Mines.

MADRAS.—The principal mines are the ***Rajahzompalli*** of the ***Godaveri*** coal-fields, but they are scarcely yet in full working order. It seems probable, from the occurrence of both coal and iron ore in Madras, that before long an important iron smelting industry will be established in this Province.

Panjab Coal Mines.

PANJAB.—The ***Dandot*** mines of the Jhelum district contain three seams about three feet thick. In 1895 they produced 72,493 tons, which were chiefly consumed on the North-Western Indian Railway; in 1896 the production had risen to 79,017 tons. Other fields are those of ***Pidh, Bhaganwalla, Chitapahar, Hazara,*** and ***Bannu,*** which, however, have not been fully explored.

Mode of Working; Labour.

For detailed information as to coal mining, coal companies, coal legislation and coal labour, reference must be made to the "Imperial Institute Hand-book on Indian Coal." The following accounts of mining in Bengal may be included here as indicative of the mode and conditions of Indian labour.

Warora, C. P.

"The system of working varies very much. At Warora, Central Provinces, where 100,000 tons per annum are wound by direct

acting engines out of two shafts 200 feet deep, the system nearly approaches the English. No women work underground, and work is constant from Monday morning to Saturday night. The work time is divided into three shifts of eight hours each. The seams, which vary from 8 to 12 feet, are worked thus:—Galleries or boards and headways are driven 12 feet wide, and 6 feet in height, leaving the roof coal and pillars 40 feet square. The coal is so hard that it has to be nicked and undercut, and then blasted down. The pillars are worked by splitting each from one headway or another, and then taking the far end off in slice. The roof coal comes with it.

MODE of WORKING: LABOUR. Warora, C. P.

"At the Mohpani collieries a similar system is worked. The difficulties met with in these mines, owing to the faulted and disturbed nature of strata, are probably unequalled in India.

Mohpani.

"The Karharbari coal-field is mainly worked by three companies, the Raniganj Coal Association, the Bengal Coal Company, and the East Indian Railway. The system here is similar to that obtaining all over Bengal. The working hours are from 6 A.M. to 6 P.M., and, perhaps, later, when extra work is required. Only four days a week real work is done, and the consequence is that collieries must have a far greater number of working places than the same output in England would warrant. All the miner's family work with him, carrying or training his coal. Picks of English pattern and make are now universal, the crowbar and single pick having been ousted. The workings are on the bord and pillar system. Pillars vary from 12 feet to 40 feet square and 40 feet by 60 feet. In the shallow mines and thin seams (7 to 8 feet) the former size obtains; in the thick seams (from 12 to 20 feet) the latter. Pillars are worked in the 8-feet seam in the following manner:—A 4-feet chock is placed between each pillar in the row of pillars (generally six in number) that are to come out. A chock is also placed in front of each; the pillar is then attacked from the front side. When pillars are taken out, the chocks are withdrawn and the roof falls.

System pursued in Bengal. Karharbari.

"The remarks on the Raniganj coal-field given below apply in some measure to this field. Of sinking, coal cutting, the miner's love of holiday, lighting of mines, etc., the description in one case is a description in the other. Payments in this coal-field are weekly, on Sunday mornings, the miners resorting from the pay offices to the East Indian Railway bazar, which was established to attract local

MODE of WORKING: LABOUR. Systems pursued in Bengal.

labour, and which has done so. The labourers consist of low class Mussulmans and Hindus, as also aborigines,—Santals and Kols. There are some Bauris, brought from Bengal to teach the local men how to cut coal. The local men, however, cut coal better, as they have discarded the Bauri *sabel*. Local labour is more tractable, and the Bauris are not in such requisition as formerly.

Drainage.

"Drainage is effectively carried out by Tangye's special and lifting and forcing pumps, worked by bob-levers from horizontal engines. The machinery is of good type, and winding and hauling are done by good engines. Ventilation is attended to in the deep mines, mainly by furnaces or steam-jets.

Miners' dwellings.

"The miners live in small villages, aggregations of huts of mud walls of bricks set in mud with thatched or tiled roof. The hut consists of one room, sometimes two, of from 6 feet by 6 feet to 10 feet by 10 feet in size. Those better off have cow-sheds and granaries; these two latter with the dwelling forming three sides of a quadrangle. The larger proportion of the labourers cultivate during the rainy season, and work at the collieries only in the cold season, say from October to June. Some of the labourers have settled down to coal cutting as a calling, and these work constantly, always excepting Monday, which is invariably a holiday.

Rates paid to miners.

"Coal cutting is paid for by contract at so much a tram or bucket. These are of various sizes. The price generally amounts to from 7 to 8 annas per ton for large, and 1½ to 1¾ annas per ton for small coal. All other work as stone cutting, sinking, rail-laying, etc., is paid for by daily wages.

Classes of coal.

"The coal is hand-picked into four kinds. Steam is larger than 2-inch cube, rubble larger than ¾-inch cube, smithy down to ¼-inch cube, and all smaller than that is called slack or dust. This picking or screening is done by contract, and for rubble and smithy the coolies get about 4 annas per ton. Slack is not paid for. Loading is done by hand into the railway wagons. At the mines tipplers are used for discharging the coal from underground trams into the wagons that run in the narrow-gauge tramways."

Raniganj.

The following notes on the Raniganj coal-field are by Mr. T. H. Ward:—

"The Chord line, East Indian Railway, passes across this coal-field, and the collieries are clustered on either side and along the Barakar branch, sidings and branches, up to six miles in length

built by private enterprise, connect most of the collieries to the main line. Here winding engines, wire-rope guides, and tipplers, and the regular paraphernalia of an English colliery are fast supplanting the primitive 'gin' and bucket of a few years ago. These gins were (and sometimes are still) turned by women, 25 to 30 being employed on each gin. They kept time to a monotonous chant which they sang as they tramped round and round. The sinking in the district is easy, through soft sandstones, no brickwork being required to protect the sides. Heavy water is sometimes met with.

MODE of WORKING: LABOUR.

Systems pursued in Bengal. Raniganj.

"The coal in the east of the field is very strong and non-caking. The sandstone roof is also very strong, and comes right down into the coal. Practically no timber is required in working the coal in the manner described below. In the west of the field, at Sanctoria for instance, the coal is not so strong, though the roof is everywhere the same. From Belrooi near Sitarampur, westwards, the seams worked are all coking coals.

Thickness of seams.

"The seams worked are seldom less than 10 feet and sometimes reach 11 feet, in thickness. In the Barakar Coal Company's Kumardubhi Colliery and the Bengal Coal Company's Liakdee Colliery on the west of the Barakar, the enormous thickness of upwards of 80 feet has been found.

Plan.

"The mine is laid out underground on the same plan throughout the district. This plan has been stereotyped all over the field, and is adopted without reference to its suitability to the different conditions obtaining in the various seams worked. Indeed, it has been adopted apparently more with reference to the prejudices of the native miner than from economical considerations. Galleries are excavated to the full height of the seams 12 feet to 16 feet wide, leaving square pillars of varying sizes to support the roof, many acres being thus often left on pillars The native cooly insists (and he has his own way very much in this coal-field) on commencing operations at the roof and working downwards until the full height of the seam has been excavated His chief and dearly-prized weapon is a 'sabal' or crowbar with sharp point at one end. With this he smashes the coal, standing always when at work. He never groves beyond the first 'cleat.' Gangs of four or five men occupy each gallery. They are paid by the bucket or tram of steam coal or small delivered at the pit bottom. If any timber has to be set

Galleries.

Usual mining Implement.

MODE of WORKING: LABOUR.

System pursued in Bengal. Raniganj.

up in a working place, a man of the carpenter caste (' *Chutar* ') who is paid a daily wage, must be sent for the purpose.

" Women and children work underground, and are principally employed in carrying the small coal and dust. They are also paid by the tram or bucket. The women often take their babies, two and three months old, down the mine, taking with them also a small cot on which the child sleeps or plays while its parents are at work.

"Access to the mines is very generally by inclines opening to the surface.

Seams.

" In the eastern part of the district the seams are for the most part flat, in the central and western parts the strata are often steep (the general dip being southerly), and intrusions (dykes) of trap rock become more frequent. The deepest shafts are about 250 feet, the largest part of the coal yet won being from much less depths. Some fire-damp has been met with in the western part of the district. Chanch Colliery (west of the Barakar), belonging to the Bengal Coal Company, was abandoned some years ago after an explosion in which several men were burnt, some of whom died. At Sanctoria, also belonging to the Bengal Coal Company, some men were burnt in 1883.

Shafts.

Fire-damp. *Conf. p 4.*

" The collieries of Kumardubhi and Liakdee have already been mentioned. Thousands of tons of coal have been won from the outcrops merely of these magnificent seams, and thousands of tons *still* remain to be worked without indenting on their resources at any greater depth.

Principal coal-cutting or mining caste.

" The 'Bauri' is the principal caste which supplies coal-cutters for the district. In some respects the Bauri colliers' characteristics are amusing, like those of his western prototype. He is very fond of getting drunk, especially at the week ends, and very disinclined to go to work on Mondays. He is good tempered and improvident; it is a difficult matter to persuade him although he is always paid a 'ticca' (contract) rate for his work and could easily increase his earnings, to do more than will, with his wife's contributions, keep the household in rice and himself in drink for the day. The nearly universal and very bad custom in this district is to pay each evening for the work done during the day. The collier or cooly has often to wait about until 8 or 9 P.M. for his money. He then goes cheerfully home, and remains up half the night drinking and singing with his companions (he is very social in his habits), incompre-

Custom of the district to pay wages daily.

hensibly happy with his tuneless tom-tom. In the morning he trudges back, very often seven or eight miles (a distance of course travelled twice a day) to work and is down the pit at 9 or 10 A.M. All day, in the intervals of work, he sucks the comforting hubble-bubble.*

MODE of WORKING: LABOUR. System pursued in Bengal. Raniganj.

"The light which the collier carries with him is exceedingly primitive. He gets an allowance of oil in proportion to the number of trams of coal he cuts. Every morning he draws at the godown sufficient for his requirements during the day with an allowance of cotton thread or old rags to serve for wick. This oil he burns in a 'chiragh,' or small piece of stone hollowed out into the shape of a boat (a piece of tile from the roof of his house is often substituted). In this he places a small quantity of oil and a portion of wick. Any oil he can save from his allowance is his perquisite, and he can carry it home. *Mahuá* and castor oil are the chief oils used. Some of the mines are lighted by kerosene, burnt in small tin lamps holding about two ounces, with small circular wicks. The native does not like this plan so well, as he cannot use it to rub on his body or to season his food, a purpose for which *mahuá* oil is used.

Allowance of oil for lighting purposes.

Kinds of oil employed.

"The ventilation of the underground workings receives very little attention, and in most collieries none at all. The great freedom from fire-damp, and the lofty seams exploited, have kept this question in the background. The ignorant native has not yet realised that his health and longevity are in question, and he has besides helped much to prevent ventilation becoming a necessity, by the wonderful power of endurance he has shown, and which enables him to work for hours at the bottom of a sinking shaft with water pouring over his naked body, or to work all day long, or day after day in driving a 'rise' gallery, perhaps hundreds of feet from any current, in an atmosphere which is fetid and laden with steam. This is a blot on the mining of the district and ought to be speedily removed.

Ventilation.

Great staying powers of native miner.

Production.

The increase in recent years of coal production in India is very remarkable. In 1895 it amounted to no less than 3,537,820 tons valued at R1,28,81,352. This is nearly half as much again as that for 1894, and an increase of more than 50 per cent. as

Conf. Table I, Appendix, p. 21.

* Syn. for native *hooka* or pipe.—*Ed.*

METHODS OF EXAMINATION.

quantity of soot sometimes remained on the under side of the lid and escaped combustion. These determinations were made in duplicate, and passed if the difference was not more than 0·3 to 0·4 per cent. at this stage. The crucible was then put into a muffle furnace with the lid half off, and heated until nothing but ash remained, when it was cooled in the desiccator and weighed. The loss was reckoned as fixed carbon, and the residue as ash; the colour of the ash will be found recorded in the tables.

Determination of sulphur.

For the estimation of the sulphur about 1·5 grams of coal were fused in a platinum dish, with 30 grams of the following fusion-mixture:—Sodium-chloride, 4 parts; potassium nitrate, 3 parts; sodium carbonate (dry), 1 part. The mixture was slowly heated, and, after a short time, it deflagrated and became liquid; when cool it solidified into a white cake, which was dissolved in boiling water; the solution was filtered, acidified with hydrochloric acid, and, while quite hot, precipitated with barium chloride. By keeping the beaker and its contents warm on the water-bath for three or four hours, the precipitate of barium sulphate was obtained in a granular form very suitable for filtering. Most of the filtering was done through a felt of asbestos placed in the bottom of a perforated platinum crucible, with the help of a water pump; this being a modification of Gooch's method. Careful test-experiments showed that, in point of accuracy, this method was at least equal to that ordinarily used, *viz.*, igniting the precipitate of barium sulphate in a crucible; it is for speed much to be preferred These estimations were made in duplicate, a difference of 0·3 per cent. being considered quite allowable after considerable experience. In some cases the sulphur left in the coke was estimated.

Drying.

Ultimate analysis.—This was conducted on selected coals in the usual manner. The coals were first dried in a current of hydrogen gas at 120° C. for half-an-hour; this was done by pushing the platinum boat containing the weighed quantity of coal into the centre of a long piece of wide glass tubing, which itself was passed through the walls of a saucepan. Hydrogen was led in at one end and allowed to diffuse through a small piece of fine tubing packed with cotton wool, inserted in a cork at the other end. A burner was lighted under the saucepan, and a thermometer fixed into a hole in the lid; a very convenient air-bath was thus obtained. The coal.

after being dried, was then burned in the usual way in a piece of hard glass tubing. The tube used was filled to a length of 15 inches with copper oxide (from wire), and to the extent of 4½ inches with lead chromate, these materials being kept in position by plugs of fine copper gauze. The total length of the tube was about 34 inches. It will be noticed that the amount of ash, as determined in the combustion, was in some cases distinctly higher than when estimated by the technical method. This is doubtless due to the presence of iron and other mineral substances in the ash, which are left in a higher state of oxidation after being heated in oxygen.

ULTIMATE ANALYSIS. Burning.

Ash.

The Calorific Equivalent has been determined by means of Thompson's calorimeter, the apparatus being previously standardised by the combustion of material of known calorific value and the necessary correction applied to the experimental numbers. The results are stated in large calories.

Thermal or calorific value.

The services rendered in connection with the experimental work by Dr. F. Lühn, Special Assistant Chemist in the Scientific Department, and by Mr. A. M. Crighton, Junior Assistant Chemist, merit official record.

Acknowledgment of services.

Results.

The results obtained in this examination are given in the tables appended to this Report, the various samples of coal being arranged under the provinces from which they were obtained (Table II.). For convenience of comparison, and also to render possible a general survey of the figures, they have been plotted in curves on the diagram * which is appended. A table of previous analyses of Indian coals is also given, to which is added, for comparison, analyses of typical British coals (Table III.). To those familiar with the technical valuation of coal the data need little explanation or comment. It will be seen at once that Indian coal varies much in composition and quality. Most of it is quite suitable for ordinary purposes, whilst some of the samples, *e.g.*, certain of those from Bengal and Central India, are of excellent quality, equal to that of some of the best British coals. It may be useful to draw attention to the characteristics of the coal of each district.

Conf. pp. 12, 23 et seq.
Conf. p. 36 to end.

Conf. p. 40.

Variation in quality of Indian Coal.

ASSAM.—The coal from *Makum* is regarded as one of the best of the Indian steam coals, though this is scarcely borne out by the

Makum.

* Not reproduced.—*Ed.*

COAL.	Report on the

RESULTS.
Assam Coal.

two samples now reported on. The ash is remarkably small, but the sulphur is high. Neither of the two samples examined contained the very high percentage of fixed carbon (75·7 per cent.) recorded by Mr. F. R. Mallet in his 'Memorandum on the Coal-fields of Assam (1876), (*see* Table III.). One of the samples gave a rather soft coke containing much sulphur, the other was non-caking.

Conf. p. 37.

Cherrapunji.

The sample from *Cherrapunji, though low in ash, contains* much sulphur. It is, however, a hard caking coal, burning like cannel. The sample examined differs considerably from that reported on by Mr. James Prinsep (*see* Table III.). An account of the Cherrapunji field has been given by Mr. T. De la Touche ('Records of the Geological Survey of India,'—Vol. 22, Part 3, 1884). The sample from *Maoflong* is similar to the other Assam coals, but differs very much from the two samples analysed by Mr. F. R. Mallet (*see* Table III., 'Records, Geological Survey of India,'—Vol. 8, 1875). The sample from the *Dikhu Valley* is a non-caking bituminous coal.

Conf. p. 36.

Maoflong.

Conf. p. 37.

Dikhu Valley.

Noticeable fact regarding Assam Coals.

All the Assam coals are remarkable in being comparatively free from mineral constituents (ash). They are probably serviceable as *steam coals, but the samples examined contain too much sulphur for* use in iron-smelting.

Khost.

BALUCHISTAN.—The *Khost* coal is tertiary and somewhat bituminous. *Of the two samples from the* Khost *colliery, that from* the Khost seam is probably a serviceable caking steam coal, containing, however, a large proportion of sulphur. That from the *Killa-Hakim* seam contains little sulphur, and has the characters of a fair caking coal which furnishes more heat when burnt than would be anticipated from the analytical numbers.

Killa-Hakim.

BENGAL.—The coal in Bengal varies greatly in quality; much of it is excellent, the fixed carbon ranging between 50 and 60 per cent., and the calorific value exceeding 6,000 cals. (= about 10 British thermal units), whilst the ash often does not much exceed, and in some instances falls below, 10 per cent., *and the sulphur is* frequently present in but very small proportion. A great deal of the Bengal coal is serviceable steam coal. Many samples cake well and contain little sulphur, and the coke is therefore suitable for iron smelting.

The fifty-three samples of Bengal coal were derived from the following collieries:—

RESULTS.
Bengal Coal.

Raniganj.	Sanctoria.
Barakar.	Searsole.
Kumardubhi.	Jemehiri.
Rajpur.	Madhubpur.
Loyabad.	Daltonganj.
Petanar	Buggutdeah in Jheria.
Karharbari (Giridih).	Barmondia.
Sodepur.	Luchipur.
Liakdee.	Ghoosick.
Nimcha.	Baratchak.
Kooldeah.	Chattabad.
Jeyramdangah.	Moulkara.
Dhadka.	Nandi.
Belrooi.	Kalipahari.
Borrea.	Kustore.
Salanpur.	Patlabari.

Karharbari.
Conf. p. 38.

The analyses of ***Karharbari*** coal agree well with those published by Dr. Saise (Table III.). From this coal a considerable quantity of coke is produced, at present chiefly in the Anchor rectangular oven, partly for locomotive service and partly for use in the East Indian Railway Company's foundry at Jamalpur.

Barakar.

The ***Barakar*** coal has the reputation of being a first-rate steam coal, and a certain quantity of coke containing very little sulphur is produced from it. ***Sanctoria*** coal is considered to be a good gas coal, so also is the ***Giridih*** coal, which is used by the Calcutta Gas Company.

Sanctoria.
Giridih.

BURMA.—Only two samples have been received from the Burma Coal Company. The origin of the coal is not stated, but it is probably derived from the ***Shwebo*** district, about 60 miles above Mandalay and four or five miles from the Irrawaddy. That from the roof of the seam is an inferior non-caking coal difficult to burn, so that its calorific equivalent could not be ascertained. That from the floor of the seam is valueless, being nearly incombustible and little better than shale.

Shwebo.

CENTRAL INDIA.—The ***Umaria*** Government Colliery in the Rewah district, from which all the samples came, produces coal

Umaria.

COAL.	Report on the

RESULTS.

Central India Coal.

Conf. p. 39.

of various qualities. None of it is first-rate or equal to the Bengal coal, the ash being high and the fixed carbon and the calorific equivalent small. The sulphur, however, is not excessive, and the picked coal may be serviceable for locomotive use and for some other purposes. It does not cake and therefore cannot furnish coke. None of the present samples are equal to that analysed by the Geological Survey in 1884 (Table III.).

Mohpani. Warora. Gadawarra.

CENTRAL PROVINCES.—Four samples were received from *Mohpani*, six from *Warora*, and three from *Gadawarra*. The Mohpani samples, sent by the Nerbudda Coal and Iron Company, are non-caking coals of fair quality, the sulphur is small, but in two samples the ash is high. They are inferior to the sample of which an analysis is on record (Table III.).

Conf. pp 39, 40.

The samples sent from the Government Colliery of Warora are all non-caking coals resembling those from Mohpani; the fixed carbon is, however, usually lower and the sulphur higher. There is said to be excellent iron-ore and limestone in the Warora district, which might be worked if a caking coal could be found. At present nearly the whole of the output of the colliery is employed on the Great Indian Peninsula Railway with which the colliery is connected by a branch railway joining the main line at Wardah Junction, about 50 miles distant.

The Gadawarra coal is somewhat similar in its proportion of fixed carbon. In two samples the ash is high but the sulphur low. This coal differs from that of Mohpani and Warora in caking well. The Gadawarra seam is not far from the Mohpani and close to the Gadawarra station on the Great Indian Peninsula Railway, about 80 miles from Jabalpur.

Hyderabad (Singareni).

NIZAM'S DOMINIONS.—The two samples of coal from *Hyderabad* (Singareni) are of fair quality as steam coals. One does not cake, and the other only slightly. In one the sulphur is low, in the other rather high, and the same remark applies to the ash.

MADRAS.—No samples were received from this Province.

Dandot. Pidh. Baghanwalla. Shahrig.

PANJAB.—The samples were obtained from *Dandot*, *Pidh*, *Baghanwalla*, and *Shahrig*. The Dandot sample is a good non-caking steam coal, with a relatively high calorific value, though low in fixed carbon. The Pidh is a similar but rather better non-caking steam coal with a somewhat high proportion of sulphur. The Baghanwalla is an inferior coal which cakes slightly. The

RESULTS.

Panjab Coal.

seam of the Shahrig district is a bituminous
ow percentage of fixed carbon but a relative high
ling on the presence of solid hydrocarbons
ceable but fast burning coal. One sample of
d another from Dandot were examined for
s. In both cases the result was unsatisfactory,
nished any appreciable quantity of oil, whilst the
rather more than one-half and the Dandot shale
of the quantity of gas obtained from good
gas was of poor illuminating power.

contained in this Report as to the Coal Deposits
ith the results of the analyses of samples taken
ncipal seams, will, it is hoped, be the means of
to the possibilities of industrial enterprise which
her enormous coal supply.

Conf. p. 2.

coal referred to in this Report, and in some
rnished by them, may be seen in the Indian Col-
rial Institute.*

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also be inspected at the Indian Museum, Economic
tta.—*Ed.*

RESULTS.

Assam Coal.

two samples now reported on. The ash is remarkably small, but the sulphur is high. Neither of the two samples examined contained the very high percentage of fixed carbon (75·7 per cent.) recorded by Mr. F. R. Mallet in his 'Memorandum on the Coal-fields of Assam (1876), (*see* Table III.). One of the samples gave a rather soft coke containing much sulphur, the other was non-caking.

Conf. p. 37.

Cherrapunji.

The sample from ***Cherrapunji,*** though low in ash, contains much sulphur. It is, however, a hard caking coal, burning like cannel. The sample examined differs considerably from that reported on by Mr. James Prinsep (*see* Table III.). An account of the Cherrapunji field has been given by Mr. T. De la Touche ('Records of the Geological Survey of India,'—Vol. 22, Part 3, 1884). The sample from ***Maoflong*** is similar to the other Assam coals, but differs very much from the two samples analysed by Mr. F. R. Mallet (*see* Table III., 'Records, Geological Survey of India,'—Vol. 8, 1875). The sample from the ***Dikhu Valley*** is a non-caking bituminous coal.

Conf. p. 36.

Maoflong.

Conf. p. 37.

Dikhu Valley.

Noticeable fact regarding Assam Coals.

All the Assam coals are remarkable in being comparatively free from mineral constituents (ash). They are probably serviceable as steam coals, but the samples examined contain too much sulphur for use in iron-smelting.

Khost.

BALUCHISTAN.—The ***Khost*** coal is tertiary and somewhat bituminous. Of the two samples from the Khost colliery, that from the Khost seam is probably a serviceable caking steam coal, containing, however, a large proportion of sulphur. That from the ***Killa-Hakim*** seam contains little sulphur, and has the characters of a fair caking coal which furnishes more heat when burnt than would be anticipated from the analytical numbers.

Killa-Hakim.

BENGAL.—The coal in Bengal varies greatly in quality; much of it is excellent, the fixed carbon ranging between 50 and 60 per cent., and the calorific value exceeding 6,000 cals. (= about 10 British thermal units), whilst the ash often does not much exceed, and in some instances falls below, 10 per cent., and the sulphur is frequently present in but very small proportion. A great deal of the Bengal coal is serviceable steam coal. Many samples cake well and contain little sulphur, and the coke is therefore suitable for iron smelting.

Coal Supply of India. (*W. R. Dunstan*) | COAL.

RESULTS.
Bengal Coal.

The fifty-three samples of Bengal coal were derived from the following collieries :—

Raniganj.	Sanctoria.
Barakar.	Searsole.
Kumardubhi.	Jemehiri.
Rajpur.	Madhubpur.
Loyabad.	Daltonganj.
Petana.	Buggutdeah in Jheria.
Karharbari (Giridih).	Barmondia.
Sodepur.	Luchipur.
Liakdee.	Ghoosick.
Nimcha.	Baratchak.
Kooldeah.	Chattabad.
Jeyramdangah.	Moulkara.
Dhadka.	Nandi.
Belrooi.	Kalipahari.
Borrea.	Kustore.
Salanpur.	Patlabari.

Karharbari.
Conf. p. 38.

The analyses of ***Karharbari*** coal agree well with those published by Dr. Saise (Table III.). From this coal a considerable quantity of coke is produced, at present chiefly in the Anchor rectangular oven, partly for locomotive service and partly for use in the East Indian Railway Company's foundry at Jamalpur.

Barakar.

*The **Barakar** coal has the reputation of being a first-rate steam* coal, and a certain quantity of coke containing very little sulphur is produced from it. ***Sanctoria*** coal is considered to be a good gas coal, so also is the ***Giridih*** coal, which is used by the Calcutta Gas Company.

Sanctoria.
Giridih.

BURMA.—Only two samples have been received from the Burma Coal Company. The origin of the coal is not stated, but it is probably derived from the ***Shwebo*** district, about 60 miles above Mandalay and four or five miles from the Irrawaddy. That from the roof of the seam is an inferior non-caking coal difficult to burn, so that its calorific equivalent could not be ascertained. That from the floor of the seam is valueless, being nearly incombustible and little better than shale.

Shwebo.

CENTRAL INDIA.—The ***Umaria*** Government Colliery in the Rewah district, from which all the samples came, produces coal

Umaria.

APPENDIX.

Annual Production.

APPENDIX.

TABLE I.

Output of Indian Collieries in 1896 and 1897.

Provinces and Districts	Name of Mines.	When opened	By whom worked.	Output of Coal in 1896.	Output of Coal in 1897.
				Tons.	Tons.
ASSAM—					
Lakhimpur (Makum mines)	Tikak . . . Ledo Valley . . Upper Ledo . .	1882	Joint Stock Company	177,259	184,271
	Tirap . . . Namdang . .	1897	...	...	.
NAGA HILLS . .	Dikhu Valley . .	1854	Assam Tea Company	92	931
	Gelakey Daikhona .	1894			330
			Total for Assam .	177,351	185,533
BALUCHISTAN . .	Khost . . . . Sharig . . .	1887 1893	North-Western Railway		
	Sor Range (Quetta) Coal Mines.		Private.		
			Total for Baluchistan .	10,572	8,876
BENGAL—					
Burdwan .	[illegible]			1,782,037	2,033,089
Bankura .	[illegible]			14,072	9,921
Hazaribágh .	[illegible]			666,919	660,655
Manbhum .	[illegible]			571,356	434,586
Sonthal Perganas	[illegible] lieries.			1,640	2,879
Darjeeling . .	Total production of Darjeeling Collieries . . .			96	1,355
	Total production of Bengal Collieries .			3,037,020	3,142,497
BURMA—					
Shwebo . .	Letkakpin (Thingadaw)	1892			
Thayetmyo . .	Tondaung . .	...			
	Total production of Burma Collieries .			22,993	11,472
CENTRAL INDIA—					
Rewah . . .	Umaria . . .	1884	Government . .	115,386	124,778
			Total for Central India .	115,386	124,778
CENTRAL PROVINCES—					
Narsingpur . .	Mohpani . .	1863	Joint Stock Company	19,542	19,975
Chanda . .	Warora . . .	1871	Government . .	121,643	111,654
	Total production of Central Provinces Collieries .			141,185	131,629
NIZAM'S DOMINIONS	Singareni . .	1887	Joint Stock Company	262,681	365,550
MADRAS . . .	Rajahzompalli .	.	Godavari Coal Company, Ltd	1,737*	...
PANJAB—					
Jhelum . .	Dandot . . . Pidh . . .	1886	North-Western Railway	79,017	79,647
	Baghanwalla . .	1893	Do. do.	6,137*	13,145

NOTE.—The figures of outturn for 1897 being now to hand, it has been thought desirable to add them to the foregoing table.—*Ed.*

* 1895.

COAL. Report on the

APPENDIX. Tabulated Results.

TABLE

Tabulated Results of

Indian Invoice Number	Imperial Institute Number.	Date.	Mine.	Whence received.	Remarks made in forwarding Sample.
			ASSAM.		
*1828	3032	4th Oct. 1894.	Makum .	Assam Railways and Trading Company (Ledo Valley).	......
6953	7082	11th Jan. 1896.	Do. .	Assam Railways and Trading Company, Limited.	2 cwts. Makum coal .
*96	1445	4th Oct. 1894	Cherrapunji .	Cherrapunji Coal-field.	......
*97	1446	Do	Maoflong .	Maoflong Coal-field .	......
8293	7778	25th Nov. 1896	Dikhu Valley.	Dikhu Valley Colliery, Nazira, Assam.	......
			BALUCHISTAN.		
*93	1441	4th Oct. 1894	Khost Colliery	Khost Colliery, Khost seam.	......
*94	1442	Do. .	Do. .	Khost Colliery, Killa Hakim seam.	......
			BENGAL.		
*99	1448	Do. .	Kumardubhi .	Barakar Coal Company, Kumardubhi Colliery.	......
7863	7311	13th July 1895	Do. .	Barakar Coal Company	One box of steam coal from Kumardubhi Colliery.
*1561	2865	4th Oct. 1894.	Raniganj	[illegible]	[illegible]
7904	7454	29th July 1896.	Do. .	[illegible]	[illegible] ganj series.

C. 1414-41.

Coal Supply of India.

COAL.

APPENDIX.

Tabulated Results.

II.

Examination of Indian Coals.

Calorific Value.	Fixed Carbon per cent	Ash per cent.	Coke per cent	Volatile matter per cent	Sulphur per cent	Caking Properties.	Colour of Ash.	Other Characteristics of the Coal.
6353	53·28	1·02	54·30	45·45	1·07	Does not cake.	Pale chocolate.	A glistening black coal, clean to handle, easily broken, conchoidal fracture.
7105	47·84	3·66	51·50	48·50	4·87	Cakes . .	Reddish brown	Very dirty and dusty coal, breaks readily with irregular fracture, alternately dull and bright.
7702	49·54	4·74	54·28	45·72	3·58	Do . .	Dark red .	A dull black coal, dirty, very hard, with cuboidal fracture.
7128	49·79	2·96	52·75	47·25	3·08	Do. . .	Yellowish brown.	Bright and clean with fossil resin in many places.
6028	51·40	2·35	53·75	46·25	3·45	Does not cake.	Dark reddish brown.	A very bright coal, black as pitch, and of conchoidal fracture; intersected with dull layers, and thin layers of a clayish mass.
6633	49·58	5·15	54·73	45·27	4·82	Cakes . .	Terra-cotta .	Clean, bright and hard but disintegrating with a white efflorescence, and with evolution of sulphuretted hydrogen.
6936	41·50	9·56	51·06	48·94	0·74	Do . .	Yellowish brown.	Clean, bright and hard, with obtuse fracture.
6567	51·48	13·85	65·33	44·67	0·53	Do. . .	Grey .	Layers of dull and bright coal, clean rounded fracture.
6490	51·35	14·95	66·30	33·70	0·63	Do. . .	Dove . .	Dull, with bright patches, fairly tough and clean.
6028	42·05	12·35	54·40	45·60	1·58	Do. . .	Fawn .	Bright, hard and dirty.
5621	49·59	11·15	60·74	39·26	1·47	Does not cake.	Light fawn .	Dull, with bright patches, rather tough, clean.

COAL.

Report on the

APPENDIX.

Tabulated Results.

TABLE

Indian Invoice Number.	Imperial Institute Number	Date.	Mine.	Whence received.	Remarks made in forwarding Sample.
			BENGAL—*contd*		
7995	7455	29th July 1896	Raniganj .	A. Whyte, Esq., Raniganj.	Coal from the village Khooseree belonging to Pandra Estates, situated 8 miles N.-W. *of Barakar and belongs* to the Lower Barakar series In this seam a band of 2 feet very dark and carbonaceous clay divides the seam into two, the top coal is 5 feet 6 inches in thickness, of bright appearance, the bottom coal is 6 feet 6 inches in thickness and is a heavier and duller looking coal
8184	7758	2[illegible]th Nov. 1895	Raghunath Chuck.	Jaganath Coal Company, Raniganj	Raghunath Chuck coal.
*652	1995	14th Oct. 1894.	Barakar . .	Barakar Iron Works .	...
7347	7099	25th Mar 1896	Do. . .	New Barakar Coal Company, through G. Alexander, Esq.	Coal taken from an incline just being opened out, situated three miles from Barakar on the Jheria Branch Railway Taken from about 10 feet below the surface.
7740	7323	25th June 1895	Rajpur . .	Manager, Rajpur Coal Company, Barakar	Coal from Rajpur Colliery, as usually obtained.
7746	7317	25th June 1896	Petana . .	Messrs. Mylne & Co., Proprietors, Petana Colliery, Barakar	Petana steam coal .
7816	7312	13th July 1896	Loyabad .	Manager, Barakar Coal Company.	Steam coal from Loyabad Colliery.
7866	7313	Do. .	Do. .	Do. do.	Do. (A special piece which was roughly ovoidal.)
*635	1984	4th Oct. 1894	Karharbari .	East Indian Railway, Karharbari Colliery, Jogiland seam.	......

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Coal Supply of India.

COAL.

APPENDIX.

Tabulated Results.

II.—*contd.*

Calorific Value.	Fixed Carbon per cent.	Ash per cent.	Coke per cent.	Volatile matter per cent	Sulphur per cent	Caking Properties.	Colour of Ash.	Other Characteristics of the Coal
6930	58.61	11.96	70.57	29.43	1.89	Cakes . .	Dirty fawn .	A dull silky coal with bright patches, breaks easily, clean.
5563	45.03	14.97	60.00	40.00	0.64	Does not cake.	Greyish pink .	Alternate layers of bright and dull coal, dirty, breaks easily with much dust
5952	53.47	18.35	71.82	28.18	0.62	Cakes . .	Greyish white .	Dull black, dirty, very hard.
5410	41.80	29.25	71.05	28.95	0.89	Do . .	Dirty white .	Dull black coal with bright patches in places, cleaves occasionally with a silky fracture, clean
6325	55.05	18.95	74.00	26.00	0.47	Does not cake	Do .	A dull coal with bright patches, fairly tough, conchoidal fracture.
6921	54.38	10.44	64.82	35.18	0.82	Cakes . .	Do .	Glistening coal composed of dull and bright portion, former tough, the latter readily broken Occurs in well-defined layers.
6380	60.54	13.04	73.58	26.42	0.87	Do . .	Light grey .	Exhibits a peculiar curved fracture Part of the sample was of dull appearance and very tough, while the remainder was bright and broke readily into small fragments.
6402	55.66	18.59	74.25	25.75	0.91	Do. .	Do .	(as above)
7040	56.45	10.77	67.22	32.78	0.51	Do .	White . .	Laminated, very clean, cleaves in small cubes

COAL.	Report on the

APPENDIX. Tabulated Results.

TABLE

Indian Invoice Number.	Imperial Institute Number	Date.	Mine.	Whence received.	Remarks made in forwarding Sample
			BENGAL—*contd.*		
*639	1983	4th Oct. 1894.	Karharbari .	East Indian Railway, Karharbar Colliery, Lower seam.	... .. .
*641	1985	Do. .	Do. .	East Indian Railway, Karharbari Colliery, Upper seam.	......
7044	7081	31st Jan. 1896.	Do. .	Manager, Giridih Colliery Company, Limited.	(Karharbari Lower Seam) from Pit Pabaridih, Giridih Coal-field
6817	7070	6th Jan. 1896	Giridih . .	Superintendent, Bengal Coal Company, Limited.	Steam coal, Giridih .
*1658	2862	*4th Oct. 1894*	*Sodepore* .	*Bengal Coal* Company, Limited.	Sodepore coal . .
*1659	2863	Do. .	Liakdee . .	Do. do. .	Liakdee coal . .
*1660	2864	Do. .	Nimcha . .	Do. do. .	Nimcha coal . .
*1662	2866	Do. .	Kooldeah .	Do. do. .	Kooldeah coal . .
8081	7453	11th Aug. 1896	Jeyramdangah.	Managing Agent, New Beerbhoom Coal Company.	Coal from Jeyramdangah, new seam.
8082	7448	Do. .	Dhadka . .	Do. do .	Coal from Dhadka, top seam.
8083	7451	Do. .	Belrooi . .	Do. do. .	Coal from Belrooi . .
8084	7452	Do. .	Borrea . .	Do. do .	Coal from Borrea, fourth seam.
7194	7097	20th Mar. 1896	Do. . .	Managing Agents, Borrea Coal Company	Salanpur coal . .
*1663	2867	4th Oct. 1894	Sanctoria .	Bengal Coal Company, Limited.	Coal from Dethagar, Sanctoria.
7851	7321	10th July 1896	Searsole . .	Searsole and Jemehiri Collieries, Searsole, Rajbati.	Searsole steam coal .
7852	7320	Do. .	Jemehiri .	Do. do. .	Jemehiri coal . .
*1664	2868	4th Oct. 1894	Madhubpur .	Bengal Coal Company, Limited.	Madhubpur coal . .

Coal Supply of India.

II.—*contd.*

APPENDIX.

Tabulated Results.

Calorific Value.	Fixed Carbon per cent.	Ash per cent.	Coke per cent.	Volatile matter per cent.	Sulphur per cent.	Caking Properties	Colour of Ash	Other Characteristics of the Coal
6644	64.80	7.37	72.17	27.83	0.42	Does not cake	Dark yellow .	Dull black, clean, not very hard.
6985	66.80	5.35	72.15	27.85	0.40	Do. . .	Yellowish brown.	Dull black, hard, clean, breaks into cubes.
6512	58.59	14.55	73.14	26.86	0.45	Cakes . .	Dove .	Dull, rather tough, breaks in every direction with little dust.
7183	60.93	9.99	70.92	29.08	0.43	Do . .	Buff . .	Clean, but rather dusty, crumbles readily, bright in layers
6653	49.95	8.48	58.43	41.57	0.29	Do. . .	Light yellow .	Bright, dirty, fairly hard.
6721	57.70	8.62	66.32	33.68	0.53	Do . .	White . .	Mixed dull black and glossy, the latter crumbles readily, clean.
5852	42.50	14.64	57.14	42.86	0.32	Do . .	Brownish yellow.	Dull and glossy laminæ, clean and hard.
6657	64.20	12.08	76.28	26.72	1.50	Do. . .	White . .	A dull black coal, clean and hard.
6809	51.36	10.61	61.97	38.03	0.79	Does not cake	Terra cotta .	Alternate dull and bright layers breaks easily in small fragments, clean.
6545	47.85	9.68	57.53	42.47	0.35	Cakes . .	Flesh colour .	Alternate bright and dull layers, breaks easily in small fragments with little dust, clean
7084	51.86	8.86	60.72	39.28	0.39	Do . .	Do .	Dull with many bright patches, clean.
6985	55.92	12.30	68.22	31.78	0.95	Do. . .	Dirty pink .	Dull, with bright patches, breaks easily in layers, clean
6215	57.31	14.86	72.17	27.83	0.75	Do. . .	Grey white .	Dull silky coal with glistening layers and patches Hard and brittle, very clean.
6380	49.41	11.29	60.70	39.30	1.63	Do. . .	Lemon yellow .	A glossy coal, hard, but with soft patches.
6512	44.25	8.87	53.12	46.88	0.33	Do. . .	Fawn . .	Alternate layers of dull and bright coal, clean, easily broken, cleaving in layers.
6320	44.60	10.90	55.50	44.50	0.20	Do. . .	Terra-cotta .	Alternate layers of dull and bright coal, hard, dusty when broken.
5698	38.80	17.12	55.92	44.08	1.54	Do. . .	Brownish yellow.	A dull coal, laminated, hard, with soft patches, clean.

COAL. Report on the

APPENDIX. TABLE

Tabulated Results.

Indian Invoice Number.	Imperial Institute Number.	Date.	Mine.	Whence received.	Remarks made in forwarding Sample.
			BENGAL—*contd.*		
*1663	2872	4th Oct 1894	Sanctoria	Bengal Coal Company, Limited.	Sanctoria coal
*1665	2867	Do	Searsole	Do. do	Coal from Searsole, Raniganj
7145	7090	6th Mar. 1896	Daltonganj	Dr Saise, through Station Master, Gya.	Daltonganj coal, Rajhira seam.
7248	7100	28th Mar 1896	Jheria	Bengal Nagpur Coal Company, Limited, through George Alexander, Esq.	Coal taken from inclines at Buggutdeah in Jheria
7249	7101	Do.	Do.	Do. do	Coal taken from a quarry at Buggutdeah. These two samples are not only surface coal, but have been exposed to the atmosphere for some months
7861	7322	13th July 1896	Barmondia	Managing Agent, Damuda Coal Company.	Coal from Barmondia Colliery.
7862	7315	Do	Luchipur	Do. do.	Coal from Luchipur Colliery.
7863	7318	Do	Ghoosick	Do. do.	Coal from Ghoosick Colliery.
7864	7316	Do	Bharatchak	Do. do.	Coal from Bharatchak or Damuda Colliery
8192	7768	25th Nov 1896	Chattabad	Katras-Jheria Coal Company, Limited, Katras Collieries, Manbhum.	Chattabad, No. 12 seam
8193	7770	Do.	Moultkara	Do. do.	Moolkara, East Colliery, No. 13 seam.
8194	7769	Do.	Do	Do. do.	Moulkara, South Colliery, No 14 seam.
8195	7771	Do	Do.	Do. do.	Moulkara, West Colliery, No. 15 seam.
8196	7772	Do.	Choitoodee	Do. do.	Choitoodee, No. 15 seam.

Coal Supply of India.

II.—*contd.*

Calorific Value.	Fixed Carbon per cent.	Ash per cent.	Coke per cent.	Volatile matter per cent.	Sulphur per cent.	Caking Properties	Colour of Ash	Other Characteristics of the Coal.
6315	49·32	10·74	60·06	39·94	1·53	Cakes . .	Yellowish grey.	A dull coal with bright patches, hard and clean.
5853	42·71	12·03	54·74	45·26	1·51	Do. . .	Fawn . .	A clean bright coal, cleaving in layers.
5591	62·35	14·04	76·35	23·61	0·92	Does not cake.	Yellowish brown	Bright coal, rather hard, not very dirty, on same pieces a small amount of white deposit.
5747	55·35	17·88	74·23	25·77	0·90	Cakes . .	White . .	Bright glistening coal, brittle and hard, in places, has a pitchy appearance.
5500	54·25	24·20	78·45	21·55	0·70	Do . .	Light grey .	Dull black coal with bright patches in places, cleaves occasionally with a silky *fracture, rather hard,* fairly clean.
6389	48·52	8·93	57·45	42·55	0·33	Do. . .	Cream . .	Clean, bright coal, easily broken, hard, but with soft patches.
6600	48·75	13·01	61·76	38·24	0·40	Do. . .	Fawn . .	In well-defined layers, part dull and part bright and glistening, clean, fairly tough, except that the bright layers crumble readily.
5954	43·69	12·16	55·85	44·15	0·095	Do . .	Light fawn .	Well defined layers of dull and bright coal, the former tough, the latter rather brittle.
6710	47·69	10·22	57·91	42·09	0·78	Do .	Fawn . .	Bright coal, fractures readily Made up of a dull and bright portion. Dull portion tough, whilst the bright is readily broken
6820	62·17	11·38	73·55	26·45	0·85	Do . .	Greyish red .	A clean, rather bright coal, easily broken.
6799	62·60	10·55	73·15	26·85	0·93	Do . .	Dirty white .	Laminated bright coal, dirty, breaks very easily with much dust.
6672	58·85	14·36	73·21	26·79	0·83	Do . .	Do .	Dull coal with bright layers, clean.
6359	58·64	13·15	71·79	28·21	0·75	Do . .	Reddish grey .	Bright coal in layers, clean.
6787	61·24	11·46	72·70	27·30	0·93	Do . .	Dirty white .	Bright coal in layers, breaks easily, clean.

COAL.

APPENDIX.

Tabulated Results.

Report on the

TABLE

Indian Invoice Number.	Imperial Institute Number.	Date.	Mine.	Whence received.	Remarks made in forwarding Sample.
			BENGAL—*concld.*		
8197	7762	25th Nov 1896	Nundie . .	Adjai Coal Company, *Limited*, *Nundie* Colliery, Raniganj	No 1 sample . .
8198	7765	Do. .	Do. . .	Do do. .	No. 2 sample.
8199	7774	Do. .	Kalipahari .	Srikistopur Coal Company, Kalipahari.	Steam coal . . .
8260	7766	Do. .	Kustore . .	Raniganj Coal Association, Limited.	Coal from Kustore Colliery, Jheria.
8261	7757	Do. .	Patlabari . .	South Barakar Coal Company, Patlabari Colliery, No. 2 seam	......
8292	7761	Do. .	Sibpur . .	Katras-Jheria Coal Company, Limited, Churnpur, Asansole, East Indian Railway, *Sibpur Colliery*	Large lump . . .
8292A	7763	Do .	Do. . .	Do. do .	Small pieces . .
8329	7767	Do .	Kustore . .	Raniganj Coal Association, Limited, 4, Fairlie Place, Calcutta	Coal from Kustore Colliery, Jheria.
8723	8110	25th Feb. 1897	Koiloodee .	Jheria Coal Company, Katras Collieries, Manbhum	Koiloodee, No. 11 seam.
			BURMA.		
*3531	6157	4th Oct. 1891.	Letkokbin .	Burma Coal Company, Limited.	From roof of seam .
*3532	6158	Do. .	Do. .	Do do. .	From floor of seam .
			CENTRAL INDIA.		
*156	1605	Do .	Umaria . .	Umaria Colliery . .	......
*312	1671	Do. .	Do. . .	Do. . .	......

Coal Supply of India.

COAL.

APPENDIX.

Tabulated Results.

II.—*contd.*

Calorific Value.	Fixed Carbon per cent	Ash per cent.	Coke per cent	Volatile matter per cent	Sulphur per cent.	Caking Properties.	Colour of Ash	Other Characteristics of the Coal.
6458	53 89	7·59	61·48	38·52	0·48	Does not cake.	Fawn . .	Alternate bright and dull layers, the dull, coal being dirty to handle.
6127	50 38	10·72	61·10	38 90	0 37	Do. .	Do. . .	Dull slaty coal with many bright patches, rather tough, clean.
6116	48 76	10 47	59 23	40 77	0 34	Do. .	Reddish grey .	A bright coal with some duller layers.
6644	63·21	9 14	72 35	27 65	0 50	Cakes . .	Do. .	Dull coal with bright layers, clean.
6666	57 15	11 30	68 45	31 55	0 63	Do. . .	Do. .	Dull coal with bright layers, easily broken with much dust, dirty to handle.
5830	54 58	8 31	62 89	37·11	0·45	Does not cake	Fawn . .	Alternate dull and bright layers, very dirty, breaks easily with much dust.
5841	52 15	8 28	60·41	39 59	0 51	Do. .	Light fawn .	Alternative dull and bright layers, breaks easily, clean
6666	63 71	8 59	72·29	27 71	0 61	Cakes . .	Reddish white.	Dull coal with graphitic lustre in oval pieces, and conchoidal fracture, breaks easily in layers with some dust, clean to handle
6401	60 23	15 90	75 13	23 87	0 83	Do . .	Dirty white .	Rather bright coal with a silky lustre, breaks easily with some dust.
†	33 57	8 50	42 07	57 93	0 33	Does not cake.	White . .	Dull black, clean and hard with rounded surfaces and fracture
†	3 58	68 39	†	28 05	0·11	Do .	Do. . .	Dull black, with glossy patches, very soft and soapy to touch, clean
5390	59 65	23 63	83 28	16 72	0 31	Do .	Do. . .	A clean dull coal with irregular cleavage, easily broken
5247	55 97	26 60	82·57	17 43	0 43	Do .	Greyish white.	Dull, soft, clean, and contains fossilized resin

† Does not burn readily.

COAL. APPENDIX. Tabulated Results.

Report on the

TABLE

Indian Invoice Number.	Imperial Institute Number.	Date	Mine.	Whence received	Remarks made in forwarding Sample.
			CENTRAL INDIA—*contd*		
7093	7091	15th Feb. 1896.	Umaria	The Manager, Umaria Colliery.	Sample from No. 3 seam, Middle area.
7094	7092	Do.	Do.	Do do.	Sample from No. 2 seam, Middle area.
7095	7093	Do.	Do	Do do	Sample from No. 2 seam, Northern area.
7096	7094	Do.	Do.	Do do.	Sample from No 3 seam, Northern area.
7927	7449	22nd July 1896	Do	Do do	Sample from No 4 seam, Northern area
7928	7450	Do	Do.	Do do	Samples from No 4 seam, Middle area "Information required as to their coking properties."
			CENTRAL PROVINCES		
*1648	2352	4th Oct. 1894	Mohpani	The Nerbudda Coal and Iron Company, Limited, Mohpani Coal Mine.	From No. 1 seam
8134	7775	Do.	Do.	Do. do.	Sample A
8135	7776	Do.	Do	Do. do.	Sample B
8136	7777	Do.	Do.	Do. do.	Sample C
*316	1665	...	*Warora*	Warora Colliery	......
*318	1657	...	Do.	Do.	......
8130	7779	1st Sept. 1896	Do	Manager, Warora Colliery.	From No. 2 pit
8131	7780	Do.	Do.	Do. do	From No. 4 pit
8132	7757	Do.	Do	Do. do	From No. 5 pit

Coal Supply of India.

II.—*contd.*

Calorific Value.	Fixed Carbon per cent.	Ash per cent.	Coke per cent.	Volatile matter per cent.	Sulphur per cent.	Caking Properties.	Colour of Ash.	Other Characteristics of the Coal
5940	63·63	15·99	79·62	20·38	0·76	Does not cake.	White . .	Small quantities of white substance between the layers in places Rather dirty to handle.
5445	56·66	23·17	79·83	20·17	1·09	Do. .	Do. . .	Similar to 7094.
5337	45·99	14·94	60·93	39·07	1·02	Do .	Do. . .	Similar to 7094 Traces of iron pyrites in cleavages, rather tough.
5481	50·38	14·98	65·36	34·64	1·82	Do. .	Do. . .	Similar to 7094 and 7095, but not so dirty to handle It also shows a silky patched appearance when cleaved
5665	43·42	21·07	64·49	35·51	1·89	Do. .	Reddish white,	Tough coal of dull appearance, cleaving in layers
5319	48·99	24·28	73·27	26·73	2·03	Do .	Dirty white ,	Dull, with small bright patches, irregular cleavage, easily broken, with much dust, dirty.
5104	42·46	24·30	66·76	33·24	0·50	Do. .	Brownish yellow.	Dull, laminated, very hard, fairly clean
6358	49·83	8·88	58·71	41·29	0·52	Do. .	Light fawn .	A shaly coal, dull, with bright spots in layers, breaks easily, dirty, gives much dust.
6336	60·64	8·33	68·97	31·03	0·47	Do. .	Do .	A dull coal, very light, breaks easily, much dust, very fibrous.
5060	50·81	11·93	62·74	37·26	1·03	Do. .	Terra-cotta .	A dull coal with some bright layers, breaks easily with much dust, very dirty.
5533	41·40	13·50	54·90	45·10	0·94	Do. .	White . .	Dull, with bright patches, clean and rather soft.
5500	40·97	12·78	53·75	46·25	1·21	Do. .	Do. . .	A clean silky coal, easily broken, cleaving in cubes
5514	39·96	11·86	51·82	48·18	0·98	Do. .	Greyish white.	Slaty dull coal with some brighter patches, rather dirty.
5082	45·12	13·80	58·92	41·08	2·37	Do. .	Do .	Same as 8130
5335	44·57	12·75	57·32	42·68	0·77	Do. .	Dirty white .	Do.

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COAL. [illegible]

APPENDIX [illegible]

Tabulated details. TABLE

Indian Museum Number.	Imperial Institute Number.	Date.	Mine.	Where sent from.	Remarks made in forwarding Sample.
			CENTRAL PROVINCES—contd.		
[illegible]	[illegible]	1st Sept. 1896.	Warora . .	Manager, Colliery Warora	From No. 1 seam, No. 2 pit.
[illegible]	[illegible]	4th Oct. [illegible] .	[illegible]	[illegible] . . .	No. 1 seam . . .
[illegible]	[illegible]	Do. .	Do. .	Do. . .	No. 3 seam . . .
[illegible]	[illegible]	Do. .	Do. .	Do. . .	No. 4 seam . . .
			NIZAM'S DOMINIONS.		
[illegible]	[illegible]	...	Singareni .	Hyderabad . . .	...
[illegible]	[illegible]	...	Do. .	Agent and General Manager, Hyderabad (Deccan) Company.	Singareni coal . .
			PANJAB.		
[illegible]	[illegible]	2nd Feb. 1896	Dandot . .	Mining Manager, Condore District, North-Western Railway.	Two boxes of Dandot steam coal.
[illegible]	[illegible]	Do. .	Pidh . .	Do. do. .	Two boxes of Pidh steam coal. These are very friable and deteriorate rapidly if exposed to the air, and when in bulk are apt to fire by spontaneous combustion.
[illegible]	[illegible]	24th Feb. 1896	Baghanwala .	Do. do. .	Two boxes of Baghanwala coal.
[illegible]	[illegible]	22nd Feb. 1896.	Pidh . .	Do. do. .	Pidh shale. It is believed to contain mineral oil and is known to contain gas. Precise information desired on these points.
[illegible]	[illegible]	24th Feb. .	Dandot . .	Do. do. .	Dandot shale, the same information desired as above (Pidh shale).
[illegible]	[illegible]	[illegible]	[illegible] . .	Executive Engineer, [illegible] District, North-Western Railway.	Takral top seam coal from Mainwar, West.

C. [illegible]

Coal Supply of India.

II.—*contd.*

Calorific Value.	Fixed Carbon per cent.	Ash per cent.	Coke per cent.	Volatile matter per cent	Sulphur per cent.	Caking Properties.	Colour of Ash	Other Characteristics of the Coal
5940	63·63	15·99	79·62	20·38	0·70	Does not cake.	White . .	Small quantities of white substance between the layers in places Rather dirty to handle
5445	56·66	23·17	79·83	20·17	1·09	Do .	Do. . .	Similar to 7094.
5337	45·99	14·94	60·93	39·07	1·02	Do. .	Do. . .	Similar to 7094 Traces of iron pyrites in cleavages, rather tough.
5481	50·38	14·98	65·36	34·64	1·81	Do. .	Do. . .	Similar to 7094 and 7095, but not so dirty to handle It also shows a silky patched appearance when cleaved
5665	43·42	21·07	64·49	35·51	1·89	Do. .	Reddish white.	Tough coal of dull appearance, cleaving in layers
5819	48·99	24·28	73·27	26·73	2·03	Do. .	Dirty white .	Dull, with small bright patches, irregular cleavage, easily broken, with much dust, dirty.
5104	42·46	24·30	66·76	33·24	0·50	Do. .	Brownish yellow.	Dull, laminated, very hard, fairly clean.
6358	49·83	8·88	58·71	41·29	0·52	Do. .	Light fawn .	A shaly coal, dull, with bright spots in layers, breaks easily, dirty, gives much dust.
6336	60·64	8·33	68·97	31·03	0·47	Do. .	Do .	A dull coal, very light, breaks easily, much dust, very fibrous.
5062	50·81	11·93	62·74	37·26	1·03	Do. .	Terra-cotta .	A dull coal with some bright layers, breaks easily with much dust, very dirty.
5533	41·40	13·50	54·90	45·10	0·94	Do. .	White . .	Dull, with bright patches, clean and rather soft
5500	40·97	12·78	53·75	46·25	1·21	Do. .	Do. . .	A clean silky coal, easily broken, cleaving in cubes
5514	39·96	11·86	51·82	48·18	0·98	Do .	Greyish white.	Slaty dull coal with some brighter patches, rather dirty.
5081	43·12	15·80	58·92	41·08	2·37	Do. .	Do. .	Same as 8130.
5335	44·57	12·75	57·32	42·68	0·77	Do. .	Dirty white .	Do.

COAL.

APPENDIX.

Tabulated Results.

Report on the

TABLE

Indian Invoice Number.	Imperial Institute Number.	Date.	Mine.	Whence received.	Remarks made in forwarding Sample.
			CENTRAL PROVINCES.—*contd.*		
8133	7773	1st Sept. 1896.	Warora	Manager, Warora Colliery	From No. 1 seam, No. 2 pit.
*1649	2853	4th Oct. 1894	Mohpani	Gadawarra	No. 2 seam
*1650	2854	Do.	Do.	Do.	No. 3 seam
*1651	2855	Do.	Do.	Do.	No. 4 seam
			NIZAM'S DOMINIONS.		
*87	1436	...	Singareni	Hyderabad	......
7803	7308	...	Do.	Agent and General Manager, Hyderabad (Deccan) Company.	Singareni coal
			PANJAB.		
7070 and 7071	7083 and 7084	3rd Feb. 1896	Dandot	Mining Manager, Colliery District, North-Western Railway.	Two boxes of Dandot steam coal.
7072 and 7073	7085 and 7086	Do.	Pidh	Do. do.	Two boxes of Pidh steam coal. These are very friable and deteriorate rapidly if exposed to the air, and when in bulk are apt to fire by spontaneous combustion.
7109 and 7110	7313 and 7314	25th Feb. 1896	Baghanwalla	Do. do.	Two boxes of Baghanwalla coal.
7118	7095	13th Feb. 1896.	Pidh	Do. do.	Pidh shale. It is believed to contain mineral oil and is known to contain gas. *Precise information desired on these points.*
7124	7096	25th Feb.	Dandot	Do. do.	Dandot shale, the same information desired as above (Pidh shale).
7691	7319	20th April 1896	Shahrig	Executive Engineer, Shahrig District, North-Western Railway.	Takral top seam coal from Mainway, West.

C. 1414-41.

II.—*concld.*

Calorific Value.	Fixed Carbon per cent.	Ash per cent.	Coke per cent.	Volatile matter per cent.	Sulphur per cent.	Caking Properties.	Colour of Ash.	Other Characteristics of the Coal.
4840	40·97	20·75	61·72	38·28	0·64	Does not cake.	Slightly yellow	Slaty dull coal with only a few bright spots, dirty, rather tough.
5314	42·61	20·13	62·74	37·26	0·39	Cakes .		
5566	41·00	19·65	60·65	39·35	0·44	Do. .		
6116	45·35	9·23	54·58	45·42	0·43	Do. .		
5544	43·55	12·71	56·26	43·74	0·29	Does not cake.	Yellowish brown.	Irregular fracture, extremely hard, dull, clean coal, with thin streaks of glossy coal.
5885	54·68	8·61	62·84	37·16	1·28	Cakes slightly.	Dark fawn .	Very tough, dull, with bright patches.
5995	38·32	13·10	51·42	48·58				
6237	39·44	10·00	49·44	50·56				
4830	29·54	36·58	66·12	33·88	2·24	Cakes slightly.	Dirty yellow .	Dull, breaks readily with irregular fracture, white substance, brown resin.
4270	27·79	39·91	67·7	32·30	2·18	Do. .	Flesh colour .	Similar to 7109.
4470	27·30	31·93	59·23	40·77	4·41	Does not cake.	Dirty white .	This shale is in layers. A resinous substance is found occasionally between the layers. Mineral oil by distillation, small. Yield of gas low, illuminating power deficient.
1943	12·84	60·99	73·83	26·17	2·86	Do. .	Light fawn .	Dull, grey black coal with soapy touch. Contains a small quantity of brown resinous matter. Mineral oil, very small, yield of gas very low, illuminating power small.
6730	38·74	11·81	50·55	49·45	1·67	Cakes . .	Creamy brown	Easily broken, a quantity of a micaceous substance between the layers.

C. 1414-41.

APPENDIX

Ultimate Analyses.

Results of Ultimate Analyses of Selected Indian Coals.

Indian Invoice Number.	Province and Mine.	Carbon	Hydrogen.	Ash	Moisture	Sulphur.	Nitrogen, Oxygen, etc.
	Assam—						
1828	Makum	77·31	5·43	1·27	3·07	1·02	11·90
96	Cherrapunji	77·75	5·83	4·74	1·45	3·98	6·25
97	Maoflong	75·05	5·17	3·23	3·15	3·08	10·32
	Baluchistan—						
93	Khost	71·38	4·97	5·57	3·85	4·82	9·41
94	Do.	70·58	5·55	10·64	2·46	0·74	10·03
	Bengal—						
99	Kumardubhi	70·43	4·70	13·85	1·86	0·53	8·63
	Karharbari—						
639	Lower Seam	80·75	4·32	7·37	1·23	0·42	5·91
641	Upper "	83·53	4·59	5·35	1·28	0·40	4·85
1658	Sodepur	72·09	4·87	9·03	3·54	0·29	10·18
1659	Liakdee	74·33	4·60	9·19	2·23	0·53	8·02
	Burma—						
3531	Letkokbin	60·25	4·64	9·28	11·55	0·33	13·95
	Central Provinces—						
1651	Mohpani	67·65	4·37	9·73	7·07	0·43	10·75

Previous Analyses.

TABLE III.

Previous Analyses of Indian Coal.

Province and Mine.	Calorific Value.	Fixed Carbon.	Ash.	Coke.	Volatile Matter.	Sulphur.	Reference.
Assam—							
Cherrapunji	...	62·0	0·9	62·9	37·1	...	J. Prinsep.
Langrin Coal-field, Khasia Hills—							
Seam No. 1	...	50·4	8·65	59·06	41·0	...	T. D. La Touche, Geol. Survey, Rec. XVII., 1884.
" No. 2	...	50·80	6·60	57·4	42·6	...	

Coal Supply of India.

APPENDIX.

Previous Analyses.

TABLE III—*contd*

Province and Mine.	Calorific Value.	Fixed Carbon.	Ash.	Coke.	Volatile Matter.	Sulphur.	References.
ASSAM—*contd.*							
Daranggiri, Khasia Hills—							
No. 1	...	47·7	7·7	55·4	44·6	..	T. De la Touche, Rec. Geol Surv., Vol. XV., Part 3, 1882.
" 2	...	51·8	2·6	54·4	45·6	...	
" 3	...	4·0	71·8	75·8	24·2	...	
" 4	...	14·0	51·8	65·8	34·2	.	
" 5	—	27·4	29·6	57·0	43·0	.	
Maoflong, Khasia Hills—							
No. 1. Dedum Hill .	...	37·8	31·6	69·4	30·6	...	F R Mallet, Rec Geol. Surv, VIII, 1875
" 2. Maobelaka .	...	55·2	1·8	57·0	43·0	...	
Makum	...	53·0	2·0	55·0	46·5	...	Hand-book, p 34 (Gas Light and Coke Company).
Makum (average) . .	...	75·70	1·12	76·82	23·18	...	F. R Mallet, 1876.
Average of 27 analyses of Assam coal	..	60·0	3·8	63·8	36·2	..	Ball's Geology.
Chittagong, A. . .	...	36·5	25·5	62·0	38·0	..	
" B. . .	...	25·9	38·3	64·2	35·8	..	
Assam coal . . .	13·99	53·42	1·60	55·02	44·98	2·51	T. H. Ward, Hand-book.
BALUCHISTAN—							
Khost Colliery . . .	..	46	4	50	50	...	Hand-book.
BENGAL—							
Raniganj (average of 31) .	...	53·9	16·17	70·07	30·63	..	Hand-book, P. N Bose, 1890.
" (North Bengal Coal Company Upper Seam)	..	74·31	10·43	84·74	14·79	0·47	Dr Saise, Hand-book.
" Alipore (average)	12·89	60·86	14·63	75·49	20·81	1·35	T H. Ward.
" (Barakar) . .	...	64·25	7·27	71·52	27·63	1·56	T H Ward, Hand-book, page 5.
" (Dhadka) . .	...	49·61	7·64	57·25	42·75	...	
" (Borrea) . .	12·35	60·70	10·03	70·73	29·27	...	
" (Belrooi) . .	11·40	53·70	9·59	63·29	35·75	...	
" (average of 16) .	...	51·08	16·27	67·35	32·65	—	Mem Geol. Survey.
" (good specimen)	...	51·80	10·70	62·50	37·50	.	

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APPENDIX.

Previous Analyses.

TABLE III.—*contd.*

Province and Mine.	Calorific Value.	Fixed Carbon.	Ash.	Coke.	Volatile Matter.	Sulphur.	References.
BENGAL—*contd.*							
Karharbari, Lower seam .	7333	66.84	9.15	75.99	24.00	0.42	
" " .	7183	67.51	11.67	79.18	20.82	0.72	
" " .	7333	64.67	9.53	74.20	25.50	0.84	
" Upper seam .	6944	60.46	11.96	72.42	27.59	0.52	Salse, Ball's Geology and Hand-book.
" Bhadua seam .	6883	61.03	13.60	74.63	25.37	0.80	
" " .	6811	61.45	18.08	79.53	20.46	...	
" Khundiha seam	6111	59.10	22.32	81.42	18.58	...	
" average . .	7083	63.66	12.33	75.99	24.01	0.66	
" (Giridih Coal, Bengal Coal Company).	86.58	60.30	14.16	74.46	25.54	...	Geol. Dept., 1891.
Karanpura (Damuda) .	..	64.5	8.5	73.0	27.0	...	
Aurunga (Damuda) . .	...	36.5	27.5	64.0	36.0	...	Ball's Geology.
Daltonganj (Koel Valley).	...	64.8	10.7	75.5	21.05	3.45	
" No. 1 . .	...	40.44	48.52	88.96	11.04	...	
" " 1A . .	...	38.78	31.32	70.10	29.90	...	T. De la Touche, Geol. Survey, Reports and Hand-book.
" " 2 . .	...	30.34	52.78	83.12	16.83	...	
" " 4 . .	...	44.50	15.10	61.60	38.40	...	
" " 9 . .	...	54.24	12.10	66.34	33.66	...	
" (Palaman Coal-field, average).	...	56.49	11.74	68.23	31.77	...	Salse, Hand-book.
Hotar (Koel Valley) .	...	55.35	10.7	66.05	33.95	...	Ball's Geology.
Darjeeling (average of 8) .	...	59.56	17.42	76.98	22.94	...	P. N. Bose, Hand-book.
Tindaria (not worked) .	...	65.22	27.68	92.90	7.10	...	T. H. Ward, Hand-book.
Antargaon seam, Barakar rocks.	...	51.25	20.49	71.75	25.25	...	Ball's Geology.
Kaigura seam, Barakar rocks.	...	45.6	12.2	57.8	42.2	...	
BURMA—							
Murray Coal Company .	13.00	50.0	13.36	63.35	36.44	...	T. H. Ward, Hand-book.

COAL.

APPENDIX.

Previous Analyses.

Coal Supply of India.

TABLE III.—*contd.*

Province and Mine.	Calorific Value.	Fixed Carbon.	Ash.	Coke.	Volatile Matter.	Sulphur.	References.
BURMA—*contd.*							
Shwebo (Burma Coal Company), seven outcrops,—							
Lwindaw	68 93	47 62	1·86	49·48	50 52	...	
Ketsobin, No. 1	55 56	41·72	8·46	50 18	49 86	...	
" " 2	33 95	21 56	39 08	60·64	39·36	...	
Letkobin, No. 1	56 58	36 22	14·16	50·38	49 62	...	
" " 2	43 21	24 28	32·32	56 60	43·40	.	
Chadouk	40·13	24 56	35 36	59·92	40 08	...	
Kodaung	36 01	35 88	21 70	57 58	42·42	...	
Letkobin seam, top coal	...	46 60	7·10	53 70	46 30	..	
" " bottom coal.	...	38 80	14·90	53 70	46·27	...	Hand-book, pp. 61, 62.
Kyetsobin outcrop, top coal.	...	44 20	7·45	51 65	48 35	...	
Kyetsobin outcrop, bottom coal.	...	36 65	14·23	50 88	49 15	...	
Kadoung	...	36 85	23·90	60 75	39·25	..	
Luindaba	...	35 10	22 50	58 60	41·40	...	
Upper Chindwin (average of 11).	.	49 95	5 30	55 25	44 73	...	
Mergui, Great Tenasserim River A.	...	30 86	23 86	54 72	45 28	.	
Mergui, Great Tenasserim River B.	...	42 52	19·32	61 84	38 16	..	Hand-book, p 65. T. W. Hughes.
Mergui, Great Tenasserim River C	...	43 27	8 99	52 26	47 74	...	
Kale Creek Coal, Chindwin Valley	...	59 29	3·11	62 40	37·60	..	D Hooper, 1887. Review of Mineral Production, 1896.
Letkokbin	...	55 71	3·48	59·19	40·81	...	
CENTRAL INDIA—							
Umana (1885)	...	71 77	16 03	87 80	12·20	Trace.	Hand-book.
"	...	65 71	8·12	74 83	25·17	...	T. H. Ward.
CENTRAL PROVINCES—							
Mohpani	...	64 to 70	10 to 15	74 to 85	12 to 22	1 00	
Warora, large coal	...	45 6	14 4	60 0	40 0	...	Hand-book.
" slack coal	...	35 5	24·0	59 5	40 4	...	

COAL. Report on the Coal Supply of India.

APPENDIX. Previous Analyses.

TABLE III.—*concld.*

Province and Mine.	Calorific Value.	Fixed Carbon.	Ash.	Coke.	Volatile Matter.	Sulphur.	References.
CENTRAL PROVINCES—*contd.*							
Warora	...	45·4	14 2	59 6	40 4	...	Ball's Geology.
Ghugus (average of 16) .	...	45 61	20 90	66 51	33·49	...	Ball's Geology.
Warora (average) . .	...	42·85	8·99	51 84	48·16	0·849	Hand-book.
Pisgaon	...	65·1	15 7	80 8	19·2	...	Ball's Geology.
Johilla (1882), not worked	...	57 95	13·55	71·50	28·50	..	Hand-book.
NIZAM'S DOMINIONS—							
Singareni, A. . . .	...	62 4	15 00	77·4	22 6	...	
" B. . . .	...	66 0	11 00	77·0	23 0	..	
" " . . .	...	56 0	12·00	68 0	32 0	...	
" " . . .	...	58 0	10·14	...	25·10	1·20	
PANJAB—							
Quetta coal (North-West Frontier).	...	51·86	4·06	55·92	42·08	...	Hand-book.

TYPICAL BRITISH COALS.

Typical British Coals.

Province and Mine.	Calorific Value.	Fixed Carbon.	Ash.	Coke.	Volatile Matter.	Sulphur.	References.
Welsh coal . . .	Average cal. val. 6-7,000 cals.	82·66	3·68	86 34	13·66	1 59	Official report on coal for navy.
Newcastle . . .		63·25	3·49	66 74	33·25	1·07	Indian Hand-book.
Bristol Lower Series (Steam).		69·35	6·16	75·51	24 49	1·55	Salse, Ball's Geology.
Bristol Upper Series (Gas).		60 67	5 60	66 27	33 73	1·36	Salse, Ball's Geology.

G. I. C. P. O.—No. 233—R. & A.—13-9-95.—2215.—G. R.

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Editor, Dr. George Watt, Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series, those on Forestry in the Forest Series. Papers of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

This sheet and the title-page may be removed when the subject-matter is filed in its proper place, according to the letter and number shown at the bottom of each page.

NOTICE.

Future issues of this publication placed under either the "Special Veterinary" or "Special Forest Series" will not be included in the annual enumeration. Such papers are printed for Departmental purposes. Their unfortunate inclusion in the system of annual numbering has led recipients of the ordinary issues to think their sets incomplete.

The fol[illegible] ng pamphlets have already appeared as Special issues, and have not accordingly been fur[illegible] hed to the public :—

[illegible] . . Nos. 8, 9, 10, 11, 13 and 15.
1894 . . No. 8.
1895 . .

[illegible] Coals [illegible]

THE AGRICULTURAL LEDGER.

1898—No. 15.

BŒHMERIA NIVEA.

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. I., B. 576-606, also Vol. VI., Pt. I. (Rhea), R. 172-213.*]

RHEA (RIHA) OR CHINA-GRASS.

A Review of existing information on Rhea or China-grass being a Revision of the account of that fibre as given in the Dictionary of Economic Products. Also a Revision of the articles on Villebrunea integrifolia *and* Maoutia Puya. *By* THE EDITOR.

Other DICTIONARY articles that may be consulted:

Maoutia Puya, *Vol V.*, M. 260.
Villebrunea integrifolia, *Vol. VI., Pt. IV.*, V. 133.

also

The Agricultural Ledger, No. 6 of 1894.



CALCUTTA:
OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING, INDIA,
1898.

Price Rs. 2 or 2s. 8d.

The objects of THE AGRICULTURAL LEDGER are:—

(1) To provide information connected with agriculture or with economic products in a form which will admit of its ready transfer to ledgers;

(2) To secure the maintenance of uniform ledgers (on the plan of the Dictionary) in all offices concerned in agricultural subjects throughout India, so that references to ledger entries made in any report or publication may be readily utilised in all offices where ledgers are kept;

(3) To admit of the circulation, in convenient form, of information on any subject connected with agriculture or economic products to officials or other persons interested therein;

(4) To secure a connection between all papers of interest published on subjects relating to economic products and the official Dictionary of Economic Products. With this object the information published in these ledgers will uniformly be given under the name and number of the Dictionary article which they more especially amplify. When the subject dealt with has not been taken up in the dictionary, the position it very possibly would occupy in future issues of that work will be assigned to it.

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INTRODUCTORY CONSIDERATIONS.

INTRODUCTION.

So much has already been written regarding the history and properties of the fibre known to Western Commerce as Rhea or China-grass, that it may seem superfluous to give another version of the old story. Indeed, it might be said of the past two centuries that, as one rhapsody has followed another, the fibre has assumed a more and more mythical position. That it possesses intrinsic merits of a high order cannot be questioned. That it is likely in the immediate future to become one of the great staples of the world's commerce would appear to be open to grave doubt. Had the fibre been easily separable and had its production been possible on a large scale, it would no doubt have long ago secured the attention necessary for participation in the early developments that stamped the 18th and 19th centuries as pre-eminently those of manufacturing progression. The ease with which cotton lent itself to Western necessities and the abundance and cheapness of the supply, left little room for rhea. The Western textile markets have been allowed to become established

An Old Story. Intrinsic Merits. Difficult of Separation. Limited Production. Future Prospects.

TEXTILE POSITION.

affairs. In consequence the pioneer manufacturer very possibly may himself have to become the producer until he has securely fixed the position of rhea. At all events past experience would seem to point conclusively to the necessity of some idea being given to the European planters and Native cultivators, as to the margin of profit that is likely to fall to them. It has accordingly come about that it is not a question of what is the lowest price at which it can be produced? It is much more—what is the highest price that the fibre is likely to secure.

Price likely to be Secured.

The Indian cultivator is by no means so hard pressed in his choice of crops that he need turn attention to rhea. And this fact cannot be too urgently brought to the knowledge of those who would look to India for a commercial supply. The effort must be made to secure a fixed and definite position for rhea in the scale of textiles in which the price (in relation to its admitted valuable properties) would be raised rather than lowered. To attempt to place it on the agriculture of the tropics as an article to be employed in admixture or substitution is to court failure. I most completely therefore concur with Mr. Charles Richards Dodge, of the United States Department of Agriculture, that the—

Choice of Crops. Conf. with paras. 46-8, 84.

Definite Position for Rhea.

"Facility to imitate all other textiles is one of the principal causes which has kept back the development of the ramie industry; and if, instead of launching out into a series of experiments, attention had been concentrated upon the exclusive manufacture of those articles to which *the properties of the plant were peculiarly and naturally adapted*, this industry would probably be in a more advanced condition than it is at present. The folly of building up a ramie manufacturing industry on a false basis, that is, employing the textile as a substitute for something else is to be deprecated. The fibre should be used in those articles of economic necessity which would appear on the market as ramie, that any distinctive merit the textile may possess will become known, not only to the ramie trade, but to consumers of the produce."

A False Basis.

It is only by pursuance of a policy, such as Mr Dodge advocates, that a fixed position can be secured and the price raised to a standard relative to its intrinsic merits and properties If the manufacturers are not prepared to fight for a high instead of a low position, the production of this fibre will remain for many years to come in its present position.

Price in Relation to Properties. Conf. with para. 130.

INTRODUCTION.

Hallucinations.

Conf. with para. 117.

Competition with Jute.

5. *Misconceptions.*—To talk of rhea competing with jute or even cotton is ridiculous. But the wildest conceivable hallucinations have disfigured the literature of this fibre, and perhaps none more delusive than the statement that rhea would drive jute out of the markets of the world. When silk is thought of as a substitute for jute then and only then need rhea be entertained as a rival for a fibre, the chief merit of which is that it is one of the cheapest of all known textiles.

Dr. Buchanan-Hamilton wrote of jute in 1808:—

Jute in 1808.

Conf. with paras. 31, 40, 84, 120

"Whether or not this plant might be employed in Europe to make cordage or canvas, I cannot say; but I hope, that no circumstance will divert the attention of the public, until a fair trial has been made with *Sann* (Crotalaria juncea), which, I have no doubt, will be found to answer just 7 as well as European hemp."

It is hardly necessary to contrast with the above opinion the actual production and manufacture that now represents the industrial value of jute to India. The first recorded exports of that fibre from India to England, occur in the return for 1828. Since then jute has become, after cotton, the most important textile of India, while *sann* hemp and rhea are in the precise position they occupied during the first decade of the century. We have to thank Dundee for this result—a result the more surprising since, while jute was but in its infancy (1853), the merits of rhea were urged on the attention of the Dundee manufacturers to no purpose.

Present Position of Jute Trade.

Rhea made known to Dundee in 1853.

6. But to return to the subject of the misconceptions that prevail regarding rhea, there would seem to be no doubt that the assurance of the inventors and owners of fibre-extracting machines, has been one of the great stumbling blocks in the progress of rhea. Each new invention or process has practically been heralded by two statements variously expressed:—

Great Stumbling Block.

(*a*) Rhea is in India a wild plant which may be easily cultivated and the fibre placed on the market for little more than the cost of collection.

(*b*) With the advent of this invaluable discovery there can be no doubt that henceforth rhea will make rapid strides toward becoming one of the most important of all known textiles.

The latter statement I pass without comment, but I desire to record a most emphatic protest against the former.

Rhea is not Indigenous to India.

Conf. with paras. 6, 7, 17, 27, 30, 37, 41, 44, 48, 49, 77, 80.

7. *Rhea not Indigenous to India.*—Rhea is not a native of India, nor even an acclimatised wild plant. Indeed so little success

has attended its acclimatisation that it nowhere exists as an escape and serves in neglected cultivation for only a very few years. As examples of misconceptions of this nature, I may quote the following:—

NOT INDIGENOUS.

"No difficulty in obtaining ample supplies has ever been anticipated, for the plant is, practically, a weed in China and India, and can be grown in any warm climate" (*The Economist, July 27th, 1895.*)

A pamphlet issued with Mr. D. Edwards Radclyffe's compliments assures its readers that—

"The weed resembles somewhat the raspberry cane, and grows, we are informed by those who take an interest in it, over the wide world." In the "*Draper's Record,*" we are informed, "It flourishes—almost as freely as the weeds in our gardens—in all tropical and semi-tropical climates, agriculturists in Java regarding it with about the same 'respect' as the British farmer does the nettle, to which family it really belongs. It grows like a raspberry cane, but is not prickly."

The comparison to the raspberry bush is just about as accurate as the statement that it is an abundant weed in the tropics. It occurs in this country purely and simply in a state of *garden not even field cultivation*, and cannot be made to give a crop unless liberally manured.

Is a Garden Crop in India.

Conf. with paras 35, 39, 47, 49, 55, 101.

Although it may be grown as a garden curiosity all over India and Burma, it is not cultivated by the people of India as a fibre plant anywhere, except in some half a dozen districts of Northern Bengal, throughout the greater portion of the valley of Assam, and in the Shan States of Burma. Experiments have been made by Europeans in other localities, and these so far have confirmed what is practically the experience in Europe, Australia and America, that there is a vast difference between the cosmopolitan endurance of the plant, and the degree of luxuriance essential to its production as a fibre crop. The only exception to this statement may be said to be the comparative success that has attended its cultivation in Kangra

Extent of Possible Cultivation.

Present Cultivation.

Cosmopolitan Endurance.

8. ***Cultivation and Fibre Production.***—Linseed is grown all over India and is one of the most important of crops, but it is well known that, in spite of the large sums expended by Government and the fortunes lost by planters, in the endeavour to produce flax we have failed to do so. The same remark is true of hemp. It is a valuable crop in many parts of the plains, yielding the narcotic, but except in the North-West Himálaya it nowhere else affords a useful fibre in its stems. The ease with which linseed,

Flax Production in India.

Hemp Production.

Conf. with para. 40.

Production of Fibre Restricted.

INTRODUCTION.

hemp, and rhea may be grown anywhere in India is, therefore, no proof that they can be made to produce fibre commercially. Were it otherwise, the very natural question would at once occur—in the case of rhea—Why has the production of the fibre not become diffused throughout the country?

Price. *Conf. with paras. 3, 4, 34, 43, 65, 71, 81, 83-4, 103, 126, 140.*

9. *Local Production and Price.*—So far as Bengal is concerned, rhea cultivation is confined at the present moment to a few districts, and probably to the identical villages within these in which Dr. Buchanan-Hamilton found in 1807. It has made no progress whatsoever, and yet the fibre sells locally at a price that one might infer should have tempted an extended cultivation. It is the most expensive of all fibres in the districts where it is found. The supply, judging from the information derived by me from the cultivators, would appear to hardly equal the demand, hence the prices were found to vary from village to village in the most erratic manner. The crudely cleaned and unbleached fibre was nowhere procurable at a price below eight annas a seer (2lb), and at that only in small quantities, the usual price was from R1 to R2-8-0 a seer. But I may here mention an actual transaction. A maund of unbleached China-grass was purchased (*25th October 1895*) by the Collector of Rungpur on behalf of my office, and the price charged came to R4-8-0 a seer. That is to say, at the rate of exchange of 1*s*. 4*d*. to the rupee, the Bengal local price averages roughly from £36 to £180 and £324 a ton for hand-cleaned China-grass.

Bengal Prices £36 to £324 a ton. *Conf. with paras. 124-6.*

London Prices £25 to £35 a ton

During the discussion of a paper read before the Society of Arts, (*2nd April 1897*), by Mr. Thomas Barraclough, one speaker said the price of China-grass in London had gone up to £35; another mentioned that he knew of contracts made recently at £25 to £26; while a third referred to a purchase made that week at £27 a ton. If these prices are to be accepted, it may be admitted that China-grass sells in India at a price higher than in London, so that, instead of exporting, India should in reality be importing the fibre to meet a remunerative demand.

Allied Plants to Rhea.

10. *Other Rhea-like Fibres.*—But while rhea is not a native of India, there are some ten species of plants that belong to the same genus (Bœhmeria) that are indigenous, and some of these are extremely plentiful and widespread. The family resemblance to the rhea plant (B. nivea) of most of these, is very generally recog-

NETTLE FIBRES.

nised by the people and one or two, more especially **B. platyphylla,** are spoken of as *ban* (wild) *riha*. But it is somewhat significant that none of the indigenous species of **Bœhmeria** are known to the people of India, generally, as affording useful fibres. In one instance, I was assured that when cultivated **Bœhmeria platyphylla** gave a fibre, but I nowhere found it either cultivated or its fibre being extracted. Indeed, as the result of recent personal explorations, I begin to suspect that a mistake may have been made by some of the earlier writers, who speak of the wild **Bœhmerias** of India, as yielding fibres. I have scraped the stems of most of them and failed to find sufficient fibre to justify the benefit of the doubt being given, that they may be viewed as fibre-yielding plants.

Ban or Wild Bœhmerias. *Conf. with paras. 52, 76-77, 83.*

Other Stingless Nettle Fibres.

On the other hand, there are three or four species of indigenous nettles all more or less allied botanically to the rhea, but which are not species of **Bœhmeria,** that are well known to yield valuable fibres. One of these is by the hill-tribes of Assam universally designated the *bon* (or *ban*) *riha*. They admit that **Bœhmeria platyphylla** is a *bon-riha*, but the plant to which I here alluded, *viz*, **Villebrunea integrifolia,** they distinguish as the true *ban-riha*. This yields a fibre of great merit to which I propose to allude in some detail further on.

Ban-riha. *Conf. with paras. 192-210.*

Then again from the Khasia Hills and along the foot of the Himálaya from below Darjeeling to Nepal and Garhwal, there occurs another fibre-yielding nettle that even more closely resembles the **Bœhmerias** than does **Villebrunea.** This is known as the *poi* or *puya* (**Maoutia Puya**). but the fibre which it affords is, I believe, comparatively worthless.

Puya. *Conf. with paras 211-225.*

From time to time both these stingless nettles, which in that respect may be designated **Bœhmeria**-like nettles, have occasionally but incorrectly been spoken of (by European writers) as wild rhea and, in consequence no doubt, has crept into existence the absolutely erroneous opinion that the rhea was a native of India, because it had been affirmed it existed in its wild state all over the country. To this circumstance may also be attributed the reputation given to some of the indigenous **Bœhmerias**, *viz*, that they afford useful fibres.

In addition to the two wild **Bœhmeria**-like fibre-yielding plants just mentioned, there are two more species that may be here alluded to briefly. These belong more correctly so speaking to the nettle

Stinging Nettles.

INTRODUCTION *Surat.*

family (or stinging nettles) and both yield well known fibres. These are the *surat* or *chorpatta* of Bengal or the *sir-nat* of Assam (Laportea crenulata*) and the *horu surat* of Assam (Girardinia heterophylla). The last-mentioned may possibly be the *mesakhee* fibre referred to Major Hannay and some of the earlier writers on the subject of the Assam nettle fibres.

Horu Surat. Conf. with para. 77.

While these stinging nettles are met with within the area of rhea cultivation, more especially on the lower hills, they are only rarely confused with rhea, and for the purpose of the present paper may, therefore, be dismissed with the remarks already offered.

11. Having thus very briefly set forth some of the practical results and conclusions arrived at during a recent exploration of the Indian areas of rhea fibre production, it seems desirable that I should now endeavour to furnish as complete a review as possible of the available information regarding this much-hackneyed subject. In doing so I shall throw the material that has been accumulating in my office for the past few years, into the form of a revision of the articles as published in the Dictionary of Economic Products on Bœhmeria nivea, Villebrunea integrifolia, and Maoutia Puya.

THE CHINESE AND INDIAN PLANT.

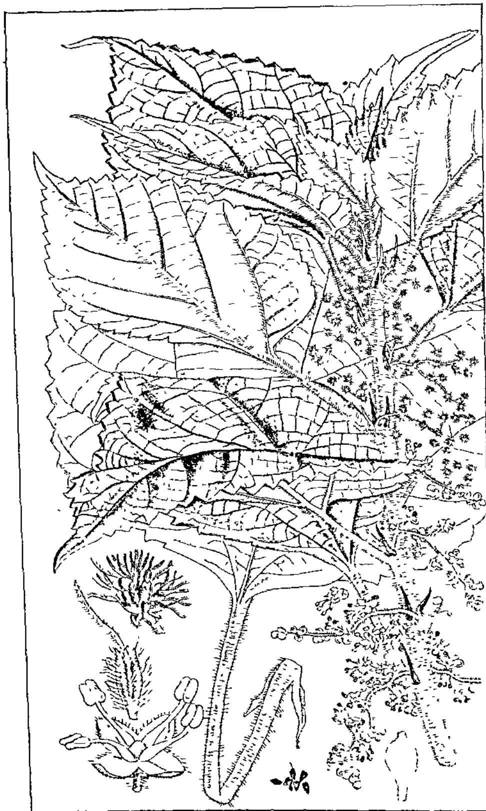
BOTANICAL LITERATURE. *Conf. with paras. 25 and (Commercial) 50*

I. Bœhmeria nivea, *Gaudich., Bot. Freyc. Voy., 499; (Excl. Syn. Ramium majus, Rumph.) ; Fl. Br. Ind., V., 575 ;* URTICACEÆ.

RHEA, CHINA-GRASS.

12. Syn.—*Plukenet, Amalt., p. 212 t. 449, f. 2, (1705 A.D.); Koempfer, Amoen. Exotic, p. 891 (1712);* URTICA NIVEA, *Linnæus, Sp. Pl., 1398 et Hort. Cliff., p. 440, No. 4 (1737); Burmann, Flora Ind, p. 197 (1768): Thunberg, Flor. Japon, p. 71 (1784): Loureiro, Flora Cochin, pp. 558-9 (1790);* U. NIVEA, *Willd., Buchanan-Hamilton in Stat. Account, Dinajpur (written 1809, republished 1833), 194, 201 ;* BŒHMERIA (PROCRIS) NIVEA, *Gaudich., Bot. Freyc. Voy., pp. 499-500 (1825); Hooker & Arnot, Voy. Beech, p. 214 (1841); Voigt. Hort. Suburb. Calc, 280; Fortune, Three Years' Wanderings in N. China, p. 53 (1847, also Specimens collected by him in Herb. Bot. Gardens, Calcutta); Macgowan, Jour. Agri-Hort. Soc. Ind., Vol. VI., pp. 209-19 (1848); Hooker, Journ. of Bot., I., 25, 159 (1849); Blume, Mus. Bot. Lugd. Bat. II., pp. 210-11*

* Masters gives an interesting account of the stinging property of this plant in Jour. Agri.-Hort. Soc. India (1848), Vol. VI, pp. 44-45.



CHINESE PLANT.

(*1849-56*); *Miquel, Plant Jungh., p. 33* (*1850*); *Hooker, Journ. of Bot., III, pp. 312-16, Pl. VIII.* (*1851*); *Weddell, Mono. Fam. des Urt., pp. 380-82 (in part) t. XI. f. 10-1* (*1856*); *Wight, Icon. t., 688. Bentham, Flora, Hongkong, 331* (*1861*); *Miquel, Flora Japon.* (*1867*); *Weddell in DC. Prod., XVI, Pt. I., 206* (*1869*); *Brandis, For. Fl., N.-W. P. and C. Ind., 402* (*1874*); *Baillon, Nat. Hist. Plants, Vol. III, 503* (*1874*). (*Excl engraving n., 541*).

Commercial Names.

Ribbons. *Conf. with paras. 43, 75, 80-2.*

13. ***Vernacular Names.***—In modern commerce RHEA appears to have been ascribed to the decorticated ribbons and CHINA-GRASS assigned to the unbleached though more or less cleaned fibre. Rhea (or *Reeha, Rīha* as it should be written), being the Indian name for this plant, might with advantage be given to the Indian produce, and RAMI, being the Malayan name, might be restricted to the variety dealt with below, or at all events to the produce of the Malay Archipelago. In other words, it seems to me an error, not only in fact but very possibly in the textile merit of the products concerned, to speak of the Indian and Malayan fibres as Rhea or Rami. These names are neither synonymous nor are the fibres in all probability derived from the same plant. It would be more in accord with the actual state of affairs to speak of Rhea and China-grass conjointly but distinct from Rami or Ramie as it is sometimes written.

Chinese Name.

Chu-ma (*tchou-ma*) is the Chinese name for the plant. *Cay-gai* and *Pa-ma* are given to it in Cochin China. *Kankhura* (or rather *Kankura*) is its most general Bengal name, but in Bogra it is called *Kund* and in some parts of Jalpaiguri the name *Kurkunda* is given to the plant. *Reeha* (*Rīha*) is its Assami name and *Rīsa,* Rusa* and *Sumsha*, were given me as Naga names for the plant. In the lower portions of the Valley of Assam such as at the foot of the Garo Hills and in Kamrup, generally it is known by its Bengali name *Kankūra*. It is *Pan* in the Shan States and *Gun* † or *Gwōn* in Burma.

Indian Names.

Riha Shawl. *Conf. with paras. 77, 107.*

14. In Assam no cultivator would recognize the word rhea. It is *rīha i. e.* pronounced *ree-ha.* The ladies of that Province wear a light muslin shawl thrown across the shoulders. This is the *rīha* or breast cloth—a garment supposed to protect the heart. An intelligent Assami gentleman, with whom I conversed in Golaghat, derived the name *rīha* from the Sanskrit *hrid*—the heart—but, as opposed

* See Naga names for Villebrunea, para. 192.
† See Malay name, para. 26.

INDIAN PLANT: RHEA.

Gauze.

to that view, it must be added that at the present day at all events the *ríha* shawl of the Assamese ladies is not made of China-grass. It is mostly a silk gauze or a mixed silk and cotton gauze or by the poorer classes unbleached cotton gauze. In every instance, however, it is a fabric woven in the peculiar manner best described by the term gauze, and it most unquestionably recalls the appearance of the fine grass cloth muslins or gauzes of China.

Rhea never Woven.

At Gauhati I was assured by an Englishman of long acquaintance with Assam and its people that the Assamese undoubtedly made fine muslin from the *ríha* fibre. I was greatly surprised and interested at this piece of information, since, so far as my experience went, both in Bengal and Assam the fibre is employed exclusively in the manufacture of fishing lines and nets. Accordingly I asked my informant to be good enough to procure for me a few samples of *ríha* shawls. The result was an extensive assortment of the gauzes mentioned above, not one of which contained a trace of rhea fibre. Indeed this may be said to be one of the most surprising features of the *ríha* or *kankura* industry of India, *viz.*, the fibre is nowhere woven into fabrics.*

Nettle Fibres Woven.

Villebrunea. *Conf. with paras. 10, 14, 77, 106, 190-210.*

But on turning attention from the plains of Assam to the adjacent hills, the various tribes that inhabit these wild countries are found to regularly manufacture cloth from one or two of the wild nettles mentioned above. The Jabaka Nagas, whom I visited in connection with the enquiry into this fibre, grow **Bœhmeria nivea** and sell the produce to the people of the plains; they call it *risa* or *rusa* (*Conf. with para. 191*). Their locally produced fabrics are chiefly woven from cotton yarns imported from the plains or from the *ban-ríha* fibre—**Villebrunea integrifolia.** In the Angami Naga country they use both **Villebrunea integrifolia** and **Girardinia heterophylla** but do not cultivate the *ríha*. It is not my purpose to deal here with these rhea-like fibres, and I would therefore conclude the present remarks regarding the names given to **Bœhmeria nivea** by offering the suggestion that, since the family resemblance between the two (**Villebrunea** and **Bœhmeria**) seems fairly generally recognised, it seems probable that **Villebrunea** is the original *ríha*† of Assam.

Probable Origin of Names *Ríha* and *Ban-ríha*. *Conf. with para. 201.*

* See remark, para 54, about its having been used in Bhagalpur to mix with silk, also Mr. Lloyd's account of the uses of fibre of Villebrunea, para. 204.

† May not the word *ríha* have been derived from the Naga names *risa*, *rissa*, the letters "s" and "h" being interchangeable? See Mr. Severin's account of Villebrunea, para. 207.

and that on Bœhmeria nivea being carried across the Chinese frontier and introduced to the cultivators of the plains, it was called *riha*, and the wild plant then became spoken of as the *ban* (wild) *riha* or *risa*. Be that as it may, it is to say the least of it remarkable, that the aboriginal tribes have fully appreciated the properties of the *ban-riha* and been able to spin and weave it, while their more enlightened neighbours of the plains can only spin the *riha* into string and make fishing nets from it. This circumstance would seem to indicate a greater antiquity for the knowledge of the textile properties of the wild as compared with the cultivated plant.

CHINESE PLANT: CHINA-GRASS.

15. ***Description of the Plant.***—It is perhaps hardly necessary for me to repeat all the descriptive details given by the majority of the botanical writers whose works have been cited above. It will serve the purpose of this paper to confine attention to a few of the more diagnostic—those in fact that may be regarded as separating the typical form of the species, from its variety described below.

It is a herbaceous, sparsely branched plant, with thick succulent, softly hairy stems. *Leaves* broad ovate, the apex accuminate, the margins coarsely dentate-serrate, and the base truncate and only slightly drawn out into the petiole, but hardly ever showing any tendency to be cordate. The veins on the lower half of the leaf are distinctly three, the midrib becoming pinnate above the middle. Under-surface felted uniformly all over with silvery wool in which only the midrib and the primary (or at most the secondary) veins show through the felted surface and bear scattered thick, hyaline hairs. *Stipules* large and persistent. *Inflorescence* mostly much shorter than the petioles, thick and crowded with clusters of flowers.

Diagnostic Characters. *Conf. with Variety, para. 27.*

Limits of Variation. *Conf. with para. 24.*

16. ***Citation of Books and Collections.***—In the above enumeration of authors I have endeavoured to cite all the more important botanical works that describe what may be taken as the typical condition of the species. As far as possible they have been mentioned in the sequence of date of publication and two of the writers—Fortune and Macgowan—have been classed as botanical authors on account of the specimens they collected being in the Herbarium of the Royal Botanic Gardens, Calcutta. I would here desire to mention that I am satisfied the two conditions of the species

Fortune's and Macgowan's Chinese Collections.

INDIAN PLANT: RHEA.

which have been recognised alike by botanists and cultivators, are but *geographical varieties*. *As a matter of convenience* accordingly I have referred all writers on the Chinese plant to this position and transferred those on the Malayan to the variety, even when I have not found their descriptions to fully bear out that isolation. The two plants are so very similar that the descriptions and even the illustrations given by the earlier authors might be placed under either form.

Sir William J. Hooker's Account of the Plant.

The earliest published illustration that could be said to be unmistakably **Bœhmeria nivea** is that given by Sir W. J. Hooker in the Journal of Botany (*Vol. III., table viii.*). I have ventured to reproduce that plate in connection with this paper, partly because it has already been given by Dr. Forbes Watson and other economic writers, and is thus prominently associated with all that has since been written on the subject, but mainly because it is a faithful representation of the plant. The leaf outlined below the twig (*see Plate I.*) shows the typical condition of the base of the full-grown leaf—not at all cordate, but with a very slight prolongation into the petiole. In young leaves a more or less cordate condition may be seen, but this disappears as the leaf expands.

Plate No. I.

Roxburgh's Drawing and Description.

Roxburgh's unpublished coloured drawing [the original of which is in the Herbarium, Calcutta (*Vol. XIV., No. 59*), and a copy of which is in the *Herbarium of the Royal Botanic Gardens, Kew*] is an illustration, as I take it, of the typical form of the species, and not of **Urtica tenacissima**—the form described by that author in the *Flora Indica*. Roxburgh's drawing has, however, been published by Wight (*Icon. Pl. t. 688*) and by many subsequent writers on Rhea as an illustration of **B. nivea** *var.* **tenacissima**.

Wight's Illustration

Is a Native of China.

17. *Habitat.*—There would seem to be no room for doubt that the typical form of the species is a native of China. It is widely distributed throughout that country as a cultivated plant and has been repeatedly mentioned as having been collected in a wild state. According to Bentham it was found by Champion abundantly in the ravines of the island of Hongkong. It is cultivated in the Straits Settlements, possibly also in the Malay Archipelago, in Japan, Formosa, the Philippine Islands, Burma, India, Australia, America and Europe. This is in fact the chief cultivated condition of the species, but I have neither seen a specimen of it recorded as a wild plant, nor have I discovered

Wild in Hongkong *Conf. with paras. 24, 30, 32.*

Area of Cultivation.

a writer who could be regarded as speaking of it as found in a wild state, anywhere except in China.

CHINESE PLANT: CHINA-GRASS.

Mr. C. B. Clarke, in a letter addressed to the Secretary, Government of Bengal (*16th June 1870*), would appear to have viewed the variety **tenacissima** as the cultivated state of the species, and the fact of its not producing seeds, he suggested, "is very strong against its existing in a wild or semi-wild state in Bengal." Further on in the same letter, however, he adds "**Bœhmeria nivea** has been found perfectly wild in Upper Assam and Burma, and I believe I saw it myself wild in the Chittagong Hills." "It has frequently been said that it grows wild in Nepal and Sikkim, but I never could find it here (Sikkim) myself nor have I ever seen a specimen." It is of course scarcely fair to Mr. Clarke to quote an official letter, written nearly 30 years ago, as expressing his present opinion. I have quoted the above passages from his letter as a type of the views currently held at the period in question. So in a like manner in the Kew Bulletin (*1888, p. 140*) the following passage occurs: "A plant, called in Assam Rheea, and in the Malay Islands, Ramie, was believed by Roxburgh to be distinct from the Tchou Ma of the Chinese, and it was named by this botanist **Bœhmeria (Urtica) tenacissima.** *In this plant there is an absence of the white-felted appearance, on* the underside of the leaves, so characteristic of the China-grass plant." These passages may be accepted as fully justifying the statement (developed in further paragraphs) that until very recently the two forms had not been separately recognised by Indian botanists, and further that no definite information existed as to which form was actually being cultivated by the people of India. I need hardly repeat, however, that the silvery white-leaved plant is the only one met with in cultivation in India The wild plants recorded from Japan, Formosa and the Malay Archipelago, I believe to be quite distinct.

Mr. C. B. Clarke's Opinion.

Conf. with para. 215.

Does not Produce Fertile Seed.

Conf. with paras. 28, 31, 79, 83, 128, 147, 170.

Reported to be Wild in Assam and Burma.

Conf. with paras. 6-7, 28, 30, 32, 215.

Variety tenacissima Believed to be Grown in Assam.

Imperfect Information Regarding Indian Form.

Conf. with paras. 19, 27, 30.

18. In the Calcutta Herbarium **Fortune's** specimen (*No. 281*) is stated to be the wild plant. *He tells us it was collected at Chekiang.* It preserves in a remarkable degree the chief peculiarities of the cultivated state except that the leaves are smaller, the stems thinner and more woody, than in the cultivated plant (his *No. 280*). One is quite prepared accordingly, for the remark made both on the label attached to the specimen and in his *Three Years' Wanderings in N. China* that "the wild variety is worthless" as a source of fibre.

Specimen [illegible] the C[illegible] E[illegible]

[illegible]

BŒHMERIA nivea. — The Chinese Plant.

INDIAN PLANT: RHEA.

Dr. Macgowan sent specimens from China in illustration of his paper on "China-grass," and he informs us that "it grows on the walls of Ningpo." It is somewhat curious that Linnæus gives very nearly the same remark, namely, that it grows on walls in China. But in the *Hort. Cliff.* he makes the still more curious observation that it is a plant which has the appearance of being American. Dr. A. Henry's specimen (*No. 4878*) collected in 1885-88 in Central China is quite typical. I have had the pleasure to receive an admirable set of botanical samples of the plant contributed by Mr. Hosie, Her Britannic Majesty's Consul at Wênchow, and these fully bear out the peculiarities of the species indicated above. But I may here mention that Mr. A. Hosie in forwarding these specimens made the following very instructive remark, "Now, although only one form of Bœhmeria is cultivated round Wênchow (B. nivea), I notice that this plant as soon as it strays from cultivation, as where seeds have been carried by the wind into loose stoney walls or on to poor soils, the silvery-white under-surfaces of the leaves quickly disappear and give place to green with white or rather flesh-coloured veins, while the stems assume a brownish colour." In neglected cultivations in India the leaves become smaller, thinner and the silvery tomentum much less dense, but I never witnessed it to have entirely disappeared and given place to a green texture with coloured veins Practically everywhere in India where B. nivea is cultivated, B. platyphylla occurs as a weed around the rhea enclosures. In that species the leaves are green below with the veins often pink and in point of shape they are by no means unlike the leaves of badly grown rhea. Indeed the cultivators in most parts of India call that species "wild rhea" though the two plants have nothing in common; certainly the one could in no way be derived from the other. I have ventured to make these observations with regard to B. platyphylla with a view to guard against any possible misapprehensions as to the recognition of supposed wild rhea or rhea that was presumed to have escaped from cultivation. So far as India is concerned, B. nivea neither exists as a wild plant nor as an escape from cultivation, and will only survive for a few years on being abandoned. Moreover, all the herbarium specimens seen by me that had been collected in China have manifested in a remarkable degree of constancy the condition of the species indicated above. In fact I have practically met with no instance, among

Dr A. Henry's Collections.

Samples by Mr. Hosie from Wenchow.

Plants Escaping from Cultivation. *Conf. with para. 28.*

Silvery Tomentum of Under-Surface is Modified. *Conf. with paras. 17, 30, 32.*

Bœhmeria platyphylla. *Conf. with para.*

Neither Wild nor an Acclimatised Weed. Does not Survive when Abandoned. *Conf. with paras. 39, 41.*

CHINESE PLANT: CHINA-GRASS.

a wide series of any very distinct tendency to approach the Sumatran form, though in cultivation I believe hybrids are by no means rare.

No Definite Evidence of Approach to Sumatran State.

19. ***Plant met with in India.***—Turning now to India it may be matter of surprise to many to learn that the cultivated plant of to-day in this country, from one end of it to the other, is the Chinese and not the Malayan form as here defined. In the Calcutta Herbarium there is an interesting series of specimens of which I may mention the following:—*Wall. Cat No. 4606 A*, collected at Rupganj on 2nd December 1867. In passing it may be here remarked that Wallich in a letter to the Secretary, Agri-Horticultural Society of India, dated September 7th, 1836, identifies samples of Assam rhea that had been furnished by Captain Jenkins as Urtica nivea and speaks of the plant as growing in the Botanic Gardens alongside of similar shrubs from the Malay Archipelago.

Wallichian Specimens.

Poah or Puya. *Conf. with paras 10, 24, 46, 215.*

Dr. Campbell's so-called *Poah* fibre plant from Darjeeling, of which he wrote in the Agri.-Horticultural Society's Journal (1848), Vol. VI., pp. 135 and 240, is not Maoutia Puya as supposed at the time, but typical Bœhmeria nivea. Mr. C. B. Clarke has very properly noted on the sheets in the Calcutta Herbarium that they are not *Poah*, and it is significant there are no specimens from Dr. Campbell under the cover of Maoutia Puya. Both Jenkins and Masters contributed samples from Assam, the latter in 1845. But in no instance is there the slightest indication that any of the Indian specimens had been collected from wild plants. In my own herbarium (and as the result mainly of personal explorations) I have the plant from Dinajpur, Rungpur, Jalpaiguri, the Duars, Kuch Behar, Bogra in Bengal; from Kamrup, Nowgong, Darrang, Sibsagar, Lakhimpur in Assam; from Kangra in the Panjab; and, through the kind co-operation of the Inspector General of Forests, from the Shan States in Burma. Though I searched with the utmost care, from village to village, I never came across a plot of land under the variety tenacissima. I can, therefore, confidently affirm that, so far as Bengal, Assam and Kangra are concerned, that form only exists here and there as a curiosity in the flower gardens of Europeans, and in all such cases the plants admittedly have been derived either from the Royal Botanic Gardens or from the Agri.-Horticultural Society's Gardens of Calcutta. It is nowhere grown by, or, so far as I could discover, known to the Native cultivators.

Recent Collections.

Absence of the Variety.

The Chinese Plant.

INDIAN PLANT: RHEA.

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Poah or Puya. *Conf. with paras 10, 44, 40, 215.*

Recent Collections.

Absence of the Variety.

R. 172-213.

BŒHMERIA nivea.

The Chinese Plant.

INDIAN PLANT: RHEA.

Burmann's Collections.

20. If the fact that Burmann mentions Urtica nivea as met with in India can be accepted as proof of his having actually seen specimens from this country, he was the first botanical author who had seen it. But it is somewhat curious that Roxburgh makes no mention of Burmann, and that he should have been unacquainted with the Indian plant until it was shown him by Dr. Buchanan-Hamilton.

First Importation of Sumatran Plants into India.

In 1803 Roxburgh procured roots from Sumatra of the fibre-yielding nettle known as "*Caloee.*" After having grown it for five years he obtained from Rungpur (and no doubt as I have just suggested through Dr. Buchanan-Hamilton) specimens of the Indian plant. *With both these growing side by side in the Calcutta Gardens* he refused to regard them as being Urtica nivea, *Linn.*, and apparently saw no reason to separate botanically the Sumatran from the Indian form. At all events he makes not the smallest allusion in the *Flora Indica*, to their differing in any respect, but, on the contrary, groups them together and endeavours to indicate one direction in which, to his mind, they differed from the Chinese plant. His words are "From the prevailing definition of that plant, '*Foliis sub-orbiculatis utrinque acutis vel base attenuatis*,' I must conclude to be a different species, for in all the plants in the Botanic Garden, originally from Sumatra, from Prince of Wales' Island and from Rungpur, they are uniformly broad-cordate." Now this character of having broad-cordate leaves is one of the diagnostic peculiarities in the separation of the Malayan from the China plant. Roxburgh *was so accurate an observer that* from the facts mentioned I should, but for one further consideration, have been prepared to at once believe that, though the plant met with in India at the present day is undoubtedly the Chinese form, at the beginning of century, its place may have been held by the Malayan condition. Unfortunately Roxburgh's unpublished illustration (already mentioned) is distinctly more like Bœhmeria nivea than B. tenacissima. It is by no means typical, however, the leaves being much too cordate.

Roxburgh did not Separate the Sumatran from Rungpur Plant.

He Separates the Sumatran from the Chinese Plant.

Plant Grown in India might have been Changed.

Roxburgh's Observations on Hemp and Flax Substitutes.

One of Roxburgh's very last contributions to Indian economic botany, was a paper entitled "*Observations on Substitutes for Hemp and Flax.*" The manuscript of that paper was written after he had left India, it was posted from St. Helena and printed in London in 1815, *thus seventeen years prior to the actual publication of his Flora Indica.* The manuscript of his great work had, however, been

CHINESE PLANT: CHINA-GRASS.

completed before his departure from India, so that the "*Observations*" may be regarded as amplifying and correcting the account given in the *Flora*. There are one or two noteworthy circumstances that may be here pointed out. In the *Flora* he only mentions, incidentally as it were, the Rungpur plant but would appear to have known comparatively little about it, since he does not give it its Bengali vernacular name. In the "*Observations*" he corrects this defect. In the *Flora* the citation of *Marsden's History of Sumatra* as also the spelling of the Malay name are incorrect, but correct in the "*Observations*" He still, however, calls the plant **Urtica tenacissima**, *R.*, and appears to have been ignorant of its existence in Assam. At all events he does not mention the name Ríha or Rhea.

Roxburgh Modifies his Description of the form tenacissima.

He corrects his botanical description in one or two directions, but these do not materially throw light on the question of the form of the species met with in India. One of these corrections may, however, be here mentioned. In the *Flora Indica* he describes the leaves as "long petioled, cordate hairy and a little hoary underneath, three-nerved." In the "*Observations*" he removes the qualification "a little," and thus describes the leaves as "hoary beneath." This modification might be viewed as an indication that he had seen a form of the plant with the leaves much more hoary than that which he had originally described. This modification in the description would be regarded as trivial, but for the circumstance that the distinction of the two forms might almost be said to turn on the appropriateness of the terms **nivea**, or **candicans** as applied to the tomentum of the under-surface The word hoary seems to have been employed by Roxburgh with the latter signification and the description "long petioled, cordate hairy" taken in conjunction with "a little hoary," would describe the Malay plant but be very inappropriate to the Chinese.

Rumphius' Plate and Description.

21. In his "*Observations*" Roxburgh tells us that he regards Rumphius' *table 79, figure 1*, as "a very bad representation of our plant; but as the description agrees pretty well, we may conclude they are the same." In Rumphius' plate the leaves are not cordate, the veination is pinnate, and the stem much branched. It is not unlike a wild state of the Chinese plant, but, as Roxburgh remarks, is certainly a bad illustration of the Malayan. It is thus just possible that Roxburgh before his departure from India had recognised the more

INDIAN PLANT: RHEA.

hoary condition of the Rungpur form without regarding that character of specific or even varietal value. But following the governing principle of his life—accuracy—it may be assumed that he had directed his artist to prepare a coloured plate of the Indian, not the Malayan plant. If this line of reasoning be accepted, we may, I think, with safety make the further inference that the Chinese and not the Malay form has, from the very earliest times, as at the present day, been grown in India, and that the reputation to the contrary, which is current in the literature of this subject, proceeded from Roxburgh having been misled by Loureiro's erroneous description of the Cochin Chinese plant.

How Roxburgh was Led into a Mistake

22. It is, however, to be regretted that in the Calcutta Herbarium there should not have been preserved the specimens collected by Roxburgh and Buchanan-Hamilton. There can be no doubt on one point, namely, that Dr Buchanan-Hamilton was the earliest authentic discoverer of B. **nivea** in India. He gave it (1808) the vernacular name of *kankhura*, and said it was an **Urtica** and possibly **nivea** of Willdenow.*

Jenkins Discovered it in Assam, 1833 *Conf. with para. 89.*

Jenkins was the discoverer of the plant in Assam or rather in Cachar. A letter from him dated 1833 (*Trans. Agri.-Hort. Soc. Ind., Vol. II., 206*) gives in abstract all that we know up to the present date. He found it on the way down from Dharumpore. It was being grown by the fishermen near their houses: it yielded two or three cuttings a year: the fibre was separated without steeping, the bark being scraped off with a knife. It was known as *Reah*, and was a species of **Urtica**. Colonel Burney has the honour of being the discoverer of the plant in Burma or rather in the Shan States. In a letter to Kyd, dated 6th December 1835, he gives full particulars as to the method of propagation by root-cuttings, the reasons for transplanting and method of cutting the shoots. It was known to the Shans as *Pan* and to the Burmans as *Goun* (*Trans. Agri.-Hort Soc. Ind., III., Vol. 11*).

Burney Discovered it in Burma, 1835. *Conf. with para. 102.*

23. ***No Structural Modifications in Plant.***—To these considerations it may be added that although the Calcutta Herbarium possesses a fairly extensive series of dried specimens of this Bœh-

* [illegible] from Dinajpur. *Conf. with paras. 39, 44 and 53.—G. Watt.*

CHINESE PLANT: CHINA-GRASS.

meria (none very possibly older than 1840) there is not a sheet of **B. tenacissima** that could be said to have been procured in India proper, all the Indian examples of that variety are admittedly derived from plants grown in the Botanical Gardens of Calcutta or of Saharanpur. While that is so, still the older of these herbarium specimens of **B. tenacissima** may have been cut from the descendants of the original Sumatran stock. If that assumption be admissible, it may be pointed out that both the dried samples in the herbarium and the live plants in the gardens are very nearly as true to the characters of the Malayan race as if they had been only just obtained from Java or Sumatra. Admitting that the two forms of the plant here indicated are but geographical races, cultivation in Calcutta for the greater part of a century would thus appear to have produced no material modifications in their structural characteristics. This fact may be exemplified by the following circumstance Mr. James Montgomery obtained his stock of plants direct from China, 1863. These have been propagated ever since by root cuttings, practically on the same field (a period of 35 years) without showing either degeneration in fibre-yielding property, exhaustion of the soil, or any structural departures from the typical condition of the Chinese plant.

No Exhaustion of Soil. *Conf. with Paras. 95, 141.*

Degree of Cultivation. *Conf. with para. 141.*

24. ***Conclusion.***—The final result of these observations regarding the form of plant now met with in Indian cultivation and of the botanical specimens preserved in the Calcutta Herbarium, may be said to be that, following Roxburgh, most Indian writers on this fibre and the majority of systematic botanists in India, Europe and America, have regarded the Indian rhea as being **B. tenacissima.** I may mention in passing by way of illustration that so late as (16th June 1870) Mr. C. B Clarke (at that time Officiating Superintendent, Royal Botanic Gardens), held that "the particular cultivated race known as Rhea in Bengal is the plant named by Roxburgh **Urtica tenacissima,** and is generally considered by modern botanists to be a mere variety arrived at by long cultivation from **Bœhmeria nivea**" (see letter No 243 to Secretary, Government of Bengal) Mr. Clarke would thus seem to have regarded the cultivated plant of China, India, and the Malay, as identical and to be **Urtica tenacissima,** *Roxb.*, the wild plant being **Bœhmeria nivea.** That explanation must now, however, be accepted as dispelled for, as already stated, the Indian plant is persistently Chinese. Throughout

The Error Regarding the Indian Plant.

Confusion between Maoutia and Bœhmeria. *Conf. with paras. 19, 46, 215.*

INDIAN PLANT: RHEA.

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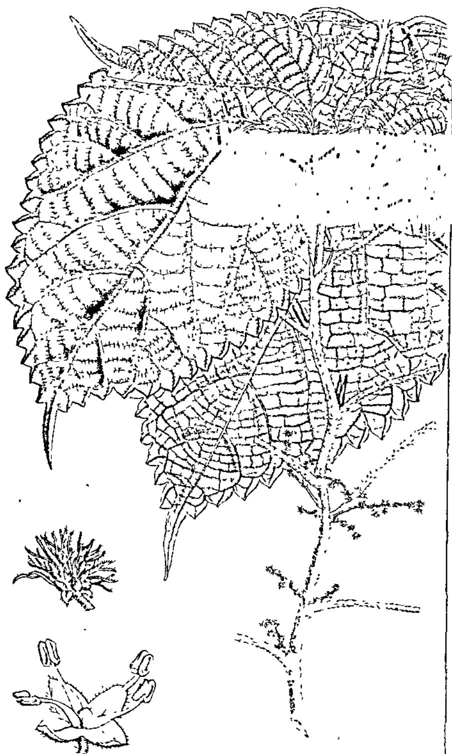
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Burney Discovered It in Burma, 1835. *Conf. with para. 102.*

23. ***No Structural Modifications in Plant.***—To these considerations it may be added that although the Calcutta Herbarium possesses a fairly extensive series of dried specimens of this Bœh-

* S[illegible]
—thro [illegible]
ton's n [illegible]
typica [illegible]
from I [illegible]



INDIAN PLANT: RHEA.

hoary condition of the Rungpur form without regarding that character of specific or even varietal value. But following the governing principle of his life—accuracy—it may be assumed that he had directed his artist to prepare a coloured plate of the Indian, not the Malayan plant. If this line of reasoning be accepted, we may, I think, with safety make the further inference that the Chinese and not the Malay form has, from the very earliest times, as at the present day, been grown in India, and that the reputation to the contrary, which is current in the literature of this subject, proceeded from Roxburgh having been misled by Loureiro's erroneous description of the Cochin Chinese plant.

How Roxburgh Was Led into a Mistake

22 It is, however, to be regretted that in the Calcutta Herbarium there should not have been preserved the specimens collected by Roxburgh and Buchanan-Hamilton. There can be no doubt on one point, namely, that Dr. Buchanan-Hamilton was the earliest authentic discoverer of B. **nivea** in India. He gave it (1808) the vernacular name of *kankhura*, and said it was an **Urtica** and possibly **nivea** of Willdenow.*

Jenkins Discovered It in Assam, 1833 Conf. with para. 89.

Jenkins was the discoverer of the plant in Assam or rather in Cachar. A letter from him dated 1833 (*Trans. Agri.-Hort. Soc. Ind., Vol. II.*, 206) gives in abstract [illegible] 214 (*Excl. t. 79*) present [illegible]; URTICA CANDICANS, *Burmann* (*possibly also U. æstuans, Burm.*), *Flora Indica, p.* 197 (1768); URTICA NIVEA, *Jacquin, Hort. Bot. Vindob., II., p. 78, t. 166*; URTICA TENACISSIMA, *Roxburgh, Flora Indica, Vol. III., p.* 590 (1820-32); U. CANDICANS, *Blume, Bijdr. Flor. Nederl., p.* 503 (1825); BŒHMERIA TENACISSIMA, *Gaudich Bot Freyc. Voy., p.* 499 (1826); BŒHMERIA CANDICANS, *Hassk., Cat. Pl., p.* 79 (1844); BŒHMERIA TENACISSIMA, *Gaudich., Blume Mus. Bot. Lugd. Bot., II, p.* 211 (1849-56); BŒHMERIA NIVEA, *Miquel in Plant. Jungh., p.* 33 (1850); BŒHMERIA NIVEA, *Hook. et Arn. var.* β CANDICANS, *Weddell in DC. Prod., XVI, Pt. I., p.* 206 (1869).

[illegible]mercial) 36.

26. ***Vernacular Names.***—*Rami*, (Java) Malay; *Inan*, Bonoa; *Gambe*, Celebes (according to Rumphius); *Moumineram*, Java (according to Burmann); *Calooe*, Sumatra (according to Marsden and in Roxburgh's *Flora Indica*, given incorrectly as *Caloose*); *Rami* (according to Crawford) throughout the Archipelago; *Rame, rami, gunn*, Malay; *Kiparoy, kapieriet, haramay lalakie*, Sund; *Klooi*, Sum.; *Inan*, Amb.; and *Gambe*, Celeb. (according to Blume); *Ramien*, Mal.; *Kloei*, Sakojan, and *Goni* a variety met with in Palembang (according to Miquel).

Conf. with Burmese Name, para. 13.

B. 576-606.

27. ***Description of the Plant.***—This would appear to be a more robust form than the plant already described. *Leaves* of a thinner and smoother texture than in B. nivea proper and with the petioles considerably longer, more slender and more hairy. The blade is ovate, distinctly cordate even in the oldest leaves, that is to say, it has the base produced into rounded lobes so that the sinus gives origin to a pronounced elongation into the petiole. Veins of the lower portion often 5, owing to a pair of slender ones lining the margins of the sinus, in addition to the three very prominent main veins. Under-surface of young leaves hoary but with open or loose white wool which, as the leaf expands, partially separates from the texture and becomes collected within the meshes of the ultimate reticulations. This gathering together of the tomentum gives the leaf a mottled appearance, but in no samples seen by me were the leaves green below. The description given by Weddell of the leaves being concolorous would be highly inappropriate to all the specimens I have examined. The veins as also the most minute reticulations (on both surfaces) are freely coated with longish stout spreading hairs that often assume (m e especially on the under-surface) a slightly rufous tint. Owing to the tomentum being collected together, the veins and reticulations in this form show up very distinct and destroy the uniformity of the white felted coating that is so characteristic of he typical condition of the species. *Stipules* relatively small. *florescence* usually longer than the petioles, at the same time more and more profusely branched than in the typical state.

MALAYAN PLANT.

Description.

Conf. with Species, para. 15.

Plate II was obligingly drawn and coloured for me under the rs of Sir George King, from a specimen grown in the Botanic ens, Calcutta. It thus represents one of the Indian cultivated of the plant, but in its natural habitat the leaves are more cordate and the inflorescence ever so much more profuse than ate. The drawing conveys the chief features of the form, ore especially the copious reticulation, abundance of hairs, green and white somewhat bluish appearance of the of the leaf. So frequently does the statement occur, in the cultivated states of this plant, that the leaves are ave at most white or pink veins, that I feel inclined be certain cultivated states with which I am un- *ara.* 32). I would therefore repeat that I have

Leaves Concolorous

Conf. with paras. 17, 18, 30.

Plate II.

Never seen with Under-Surface Green.

Conf. with paras. 17, 19, 30

MALAYAN PLANT.

Description *Conf. with Species, para. 18.*

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Leaves Concolorous. *Conf. with paras 17, 18, 30.*

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Plate II.

Never seen with Under-Surface Green. *Conf. with paras 17, 18, 30.*

hesitation, *Wall. Cat. No. 4606 E.** In some respects this specimen looks as if it might have been a hybrid between the two forms. The chief objection to admitting the idea of hybridisation, so far as India is concerned, lies in the well-known fact, first prominently made known by Roxburgh, in the case of the Malay plant (*Observations, p. 72*), that in India both forms rarely produce fertile seed. The Wallichian specimen mentioned, has the copiously branched and lax inflorescence as also the thin delicate hairy and minutely reticulate leaves of the variety, but the leaves could hardly be described as cordate, which they certainly are in the Malay plant. Then there is a sheet in the Calcutta Herbarium, contributed by Royle, doubtless obtained from the Saharanpur Botanical Gardens though this is not so stated It has every one of the characters of the Malay plant.

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Wallichian Specimen. *Conf. with para. 29.*

Production of Fertile Seed. *Conf. with para. 83. See also next page.*

Royle's Specimen.

Turning now to the botanical specimens in the Calcutta-Herbarium that have been procured direct from the Malay, I would mention Griffith's (Kew distri.) *n 4564;* Cuming's *n. 2311* from Malacca; *Jungh. Herb. n 21* from Sumatra; Teijsmann's *n. 3966* from Sumatra (where it is called *Kloe*); H. Kunstler's *n. 356*, collected in August 1880 at Salangor. This is described as "small tree on the sides of a hill on rocky ground. Leaves dark green, underneath silvery grey. Flowers yellowish, very small." This would therefore seem to be a wild state of the plant. It bears out the characters already indicated though the leaves are smaller, thicker and the stems thinner and more woody than in the cultivated fibre-yielding plant. The specimen here mentioned bears in fact an exactly parallel relation to the Malay cultivated stock that Fortune's wild plant bears to the Chinese

Griffith's and Cuming's Malacca Specimens.

Teijsmann's Sumatran Specimen.

Kunstler's Specimen from Salangor.

A Wild Specimen. *Conf. with paras 17, 30, 32.*

Lastly, in the Calcutta Herbarium there are four very instructive sheets recently contributed by Mr. C. Curtis from the Penang Botanic Gardens. No. 1 is said to be "a tall woody form originally collected at Tanyong Bunga, Penang, probably introduced by China" No. 2 "obtained from Singapore Botanic Gardens: strong growing but not so strong as No 1 and under-side of the leaves silvery grey." I am of opinion that both these plants are conditions of Bœhmeria nivea *var.* tenacissima though No 2 has much shorter inflorescence than

Curtis' Collections from Penang.

* [illegible] f examining [illegible] Herbarium [illegible] here can be [illegible]

BŒHMERIA nivea. | The Malayan Plant.

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seen no plant cultivated in India nor any herbarium specimens of the Malay form, in which the leaves could for a moment be spoken of as green on the under-surfaces. Neither Roxburgh's description nor his coloured plate could be held to justify any such interpretation being put on his **Urtica tenacissima.**

28. ***Citation of Authors and Collections.***—It has been with considerable hesitation, however, that I have advanced the above synonymy of this form. In some instances I have been guided mainly by the habitat of the plant. There would seem to be little doubt that Burmann was the first author who isolated the Chinese from the Malayan condition of the species. But for the very imperfect description published by him, the variety here dealt with, by following the rule of priority, should have been distinguished by the name which he gave it, and indeed that course has been pursued by Weddell. On the other hand, there can be no doubt that Roxburgh was describing the Sumatran plant (and his description is an exceedingly good one) when he introduced the name **Urtica tenacissima.** Whether he was correct or incorrect in subsequently placing the Indian plant under that species, cannot be supposed to destroy his description of the Malayan plant. It accordingly seemed to me desirable to accept the position advanced by Miquel more especially since he was the first botanist to publish a correct definition of the variety as distinct from the typical state of the species.

Weddell's Classification.

Miquel's Views.

Jacquin's Coloured Illustration.

But contrary to all other writers I have placed Jacquin's description and admirable coloured plate under this form, while I have transferred Roxburgh's unpublished drawing and Wight's copy of it from the variety to the typical condition. To the planter and manufacturer botanical nomenclature is of secondary consideration and, in fact in this case, it is even to the botanist not material whether Weddell or Miquel should be regarded as having the prior claim of correctly placing the Malayan plant as a variety under **Bœhmeria nivea.** In consequence I have thought it desirable to preserve the better known varietal name of **tenacissima** rather than to give it what was very possibly its earliest name, **candicans.**

Better known Name.

Specimens in Calcutta Herbarium.

It is somewhat curious that in the Calcutta Herbarium there should be no sheets of **B. nivea,** stated to have been obtained from the Gardens, while there are no less than four separate collections of the present variety. Of this nature I would mention, with

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Wallichian Specimen.

Conf. with para. 29.

Production of Fertile Seed.

Conf. with para. 83. See also next page.

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Griffith's and Cuming's Malacca Specimens.

Teijsmann's Sumatran Specimen.

Kunstler's Specimen from Salangor.

A Wild Specimen.

Conf. with paras. 17, 30, 32.

Turning now to the botanical specimens in the Calcutta-Herbarium that have been procured direct from the Malay, I would mention **Griffith's** (Kew distri.) *n. 4564*; **Cuming's** *n. 2311* from Malacca; *Jungh. Herb. n. 21* from Sumatra; **Teijsmann's** *n 3966* from Sumatra (where it is called *Kloe*); **H. Kunstler's** *n. 356*, collected in August 1880 at Salangor. This is described as "small tree on the sides of a hill on rocky ground. Leaves dark green, underneath silvery grey. Flowers yellowish, very small" This would therefore seem to be a wild state of the plant. It bears out the characters already indicated though the leaves are smaller, thicker and the stems thinner and more woody than in the cultivated fibre-yielding plant. The specimen here mentioned bears in fact an exactly parallel relation to the Malay cultivated stock that **Fortune's** wild plant bears to the Chinese

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* [illegible] f examining [illegible] Herbarium [illegible] here can be [illegible] is the present variety.—G. Watt.

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Modifications in the Inflorescence.

Saharanpur Cultivated Stock.

Production of Fertile Seed.

Conf. with paras. 28, 31, 79, 83, 128, 147, 179.

is usual. But I am disposed to suspect that, with a plant that rarely produces fertile seed and is mainly propagated by root cuttings, a wide latitude must be allowed for the peculiarities of the inflorescence

In this connection I may mention a fact recently communicated to me by Mr. Gollan, Superintendent of the Botanic Gardens, Saharanpur, namely, that while the sub-tropical state (B. nivea, proper) never produces fertile seeds in Saharanpur, the more tropical condition (*var.* tenacissima) does so regularly. This may perhaps be accounted for by the long cold season, followed by the sharp hot dry season, tending to suspend the activity of shoot production and facilities for root propagation. The plant is thus compelled through adverse climatic conditions to reproduction by seed. On the same line of reasoning it may be mentioned that, as stated by Roxburgh, the Sumatran plant does not produce fertile seed in the warm damp climate of Calcutta, while in Rungpur and to some extent in Assam also, the Chinese form frequently yields fertile seed.

But to conclude this reference to the Curtis' Penang specimens it may be mentioned that Nos 3 and 4 are typical examples of B. nivea. Regarding No. 3 Mr. Curtis notes on the label "received from abandoned Chinese garden Height about four feet. Leaf-stalk pink (a very distinguishing feature) This is the variety referred to by Mr. Ridley in Bulletin No 7 as having hollow stems."

Intermediate Forms.

Conf. with paras. 18, 28.

29. ***Indian Hybrids.***—I would here add by way of concluding these remarks regarding tenacissima that I have collected both in Bengal and Assam a very extensive series of specimens that might very possibly be supposed to be intermediate in certain respects to B. nivea proper and the variety tenacissima. Whether these were originally derived from the former or the latter I am unable to decide, but am inclined to think they might more properly be looked upon as hybrids. In all these the petioles are greatly elongated, and while the base of the leaf is never cordate it is drawn out into the petiole in the manner characteristic of tenacissima. Further the tomentum is much thinner or less copious, than in the typical plant and in old leaves becomes gathered together in tufts especially near the veins, in a manner very similar to the condition present in tenacissima. Moreover, while the under-side of the leaf is certainly never green nor devoid of a woolly coating, the veins are often broad and succulent looking, also coloured, while the leaf-

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stalks are unusually hairy, that is to say, they are clothed in long spreading hairs.

For convenience of future reference I may quote here the numbers given by me to the more striking manifestation of this condition No. 12139, collected at Jalpaiguri; No. 12201, collected in Rungpur; Nos. 12207 and 12210, collected in Bogra. No. 12249, collected at Sibsagar; and Nos. 12325, 12329, 12333, 12338, 12349, 12350 and 12367, collected in Kamrup in Assam. The Kamrup specimens were procured for me by a Native plant collector whom I sent on tour through that district with instructions to visit every known rhea-producing village. The abundance of this form in Kamrup (North bank only) is somewhat significant. And there is a further circumstance that I may here add in connection with Kamrup; the same plant collector brought me two specimens which he at first said he had found in the jungles, but which, he subsequently admitted, were discovered near villages and on deserted fields. These match to a nicety Fortune's wild rhea from China. The stems are thin and woody and the bark chestnut coloured. The leaves are not more than an inch and half in length, but in shape and condition of tomentum they are B. nivea proper and possess none of the peculiarities that I have mentioned above, of the presumed hybrid state of what is so characteristic of much of the Kamrup cultivated stock.

Assam Probable Hybrids.

Degenerated Conditions. *Conf with paras. 18, 43.*

30. ***Habitat.***—After what has already been said and the citation given of authors and specimens, it need hardly be remarked that this form can almost with safety be regarded as indigenous to the Malay Archipelago. It has been the *Rami* of all writers regarding that region, during the past 200 years at least. Rumphius does not, however, mention it as met with, except under cultivation and, indeed, none of the older authors speak of having seen it in a wild state. The very frequent application of certain vernacular names (not known outside the Malay, except as derived from that Archipelago); the antiquity and derivation of these names; and the constancy of the type of plant from the region in question, leaves little room for doubt, however, as to its being a native of that area. Moreover, some of the modern writers and indeed not a few botanists affirm that it does exist, even to the present day, as a wild plant in the Malay Archipelago.

Indigenous to the Malay. *Conf. with paras. 17, 28, 32, also 18, 29.*

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Erroneous Notions Regarding Habitat of this Plant.

It would, perhaps, serve no very useful purpose to furnish an extensive series of passages indicative of the erroneous notions that have been currently held regarding this plant. The following which appeared in 1897 in "*The Indian Daily News*" may be accepted as fully representative: "The Bœhmeria tenacissima is the name of the variety found in Central America, which is there known under the name of Ramie and does not occur in India." The above appeared in a review on a *Note on the Cultivation of Rhea in Assam* by Mr. Monahan, Director of Land Records and Agriculture in that Province. The writer of the review continues, "Mr. Monahan does not say this: but we do." As a garden curiosity the variety tenacissima is no doubt experimentally grown in America as it is in India. It was found by me in that condition in Assam on more than one occasion, and may be seen at the Botanic Gardens, and I believe also at the Agri-Horticultural Society's Gardens, Calcutta. But if the idea of hybrids between the two forms be admitted, India possesses an extensive series, and these very nearly of necessity involve the previous existence of B. nivea *var.* tenacissima.

Possible Previous Existence: *Hybrids*

Plant with Leaves Green below. *Conf. with paras 17, 18, 27.*

Dr. Morris (Assistant Director, Royal Gardens, Kew), in his lecture delivered before the Society of Arts (October 4th, 1895) makes the following observation regarding this plant: "The term ramie or rhea, should only be applied to the variety tenacissima. This differs from the type by its more robust habit and larger leaves, which are green on both sides. This character easily distinguishes it from China-grass, which has leaves white-felted beneath. The distinction here suggested is an important one. Ramie or rhea is a native of Assam and the Malay Islands. It thrives only in tropical countries, and it is useless to cultivate it elsewhere."

Suitability to Tropical Regions.

In the Dictionary of Economic Products (*Vol. VI., Pt. I., pp. 44-46*) I advanced the opinion that the Malay plant, being a native of a damp tropical region, might be better suited to many parts of India than the Chinese plant. At that time, having not personally explored the areas of rhea cultivation, I fell into the common error of regarding the rhea plant of Assam as the same as the *rami* of the Malay. From what I now know I have no hesitation in affirming that rhea and China-grass are synonymous names for Boehmeria nivea, and that the name *rami* should be exclusively assigned to the variety tenacissima. But I have no evidence of any kind that

Rhea and China-grass Synonymous.

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would go to support the notion that either the one or the other is a native of Assam.

Comparative Value as Fibre yielding Plants. *Conf with para. 33.*

31. ***Comparative Value.***—Whether as a fibre-yielding plant it is superior or inferior to the China-grass, remains one of the most important problems for the future to solve. Mr. Ridley, Director of the Botanic Gardens, Singapore, is entitled to speak authoritatively on this point. In a recent paper of his that appeared in the "*Straits Times,*" he says :—

The Green and the White-leaved Forms. *Conf with paras. 17, 18, 27, 30.*

"There are two distinct varieties of Ramie or China-grass, Bœhmeria nivea, in which the backs of the leaves are white, and Rhea, B. nivea variety tenacissima, in which the backs of the leaves are green. The English and Native names are often jumbled up, but it will be understood that, in these notes Rami is the white and Rhea the green-leaved form. Now, Rhea fibre is always considered much inferior to Ramie, but it is commonly said that Rhea, which is a native of tropical regions, would probably be better for East Indian cultivation than Ramie which is said [illegible] absolutely be grown out of doors [illegible]owever, Ramie grows remarkably [illegible]rom Sumatra, does not appear so strong or healthy."

Why Mr. Ridley should have given the Malay name to the Chinese plant and translated the Assam name to the Malay plant is a little difficult to understand This much is certain (as already remarked) that it would be more in accord with the botanical histories of the two plants to speak of China-grass and Rhea as synonymous terms, denoting **B. nivea,** and to restrict the Malayan name *Rami* to the plant of the Malay Archipelago. But I concur with Mr. Ridley most willingly on one point, namely, the remarkable adaptability of *these plants to climatic conditions Contrary to all my preconceived* notions I am free to admit I met with little, in the behaviour of **B. nivea,** during my recent investigations, that would justify the conclusion that it cannot be successfully cultivated in certain portions of tropical India. Indeed it seems to flourish alike in moist subtropical and dry warm temperate regions. But we have had *no* sufficient experience in India with the Malayan plant to authorise any opinion being framed as to *its* behaviour and value as a fibre crop. From the presumption that it is a native of the Malay it might be assumed to be a tropical condition of the species, but both forms manifest a remarkable power of adaptability to environment.

Adaptability to Climatic Conditions.

R. 172-213.

RAMI.

Production of Fertile Seed. *Conf with paras. 17, 28, 83.*

It is probable that even in their wild states both plants are largely perpetuated by root development and naturally produced cuttings. So much would this appear to be so that it has already been suggested that the tendency to form seed may be looked upon as an unfavourable prognostication, *viz.*, unsuitability as a fibre-yielding plant to the climatic conditions of the region of cultivation.

Green-leaved Form. *Conf. with paras. 17, 18, 27, 30, 31.*

32. ***Japan and Formosan Plant.***—Before leaving the subject of the probable habitat of this form I take this opportunity to say that, in the Calcutta Herbarium there is a specimen of a form said to have been collected at Yokohama in 1862. This was issued from the *Herb. Hort. Bot. Petropolitani* by **Maximowicz.** It is in my opinion **B. nivea,** *Gaud.* **β. tenacissima,** but is possibly entitled to recognition as a sub-variety. It differs from the Malay stock by *the leaves being much smaller, and, while copiously covered with* hairs on the veins and reticulations, is sparsely coated with silvery tomentum. (*Conf with para. 27.*) Could this be the origin of the cultivated plant spoken of by many authors in which the leaves are green below? The base of the leaf is not at all cordate. The plant is in fact practically intermediate between the Chinese and Malayan form. **DeCandolle** says that according to **Franchet & Savatier** (*Enum. Plant Jap., I., 439*)—what is possibly the plant just mentioned—"exists in Japan in clearings and hedges." So again **Henry's** specimen from Formosa, which is stated to have been found "wild," is very much more like the Japanese than either the Chinese or the Malayan plants.

It would thus seem probable that the cultivated fibre-yielding plants may have been derived from three independent stocks, *viz.*, the Chinese, the Japanese (including the Formosan), and the Malayan.

CULTIVATION OF RHEA IN INDIA.

The Chinese not Malayan Plant.

33. Having in the foregoing paragraphs attempted to bring together the more important considerations connected with this plant, from the botanical standpoint, it may now be desirable to set forth some of the chief particulars that have been recently brought to light regarding it as an Indian fibre crop. It may be taken for granted that my botanical investigations have revealed the fact that in India, the Chinese, and not the Malayan, plant is at present being cultivated. In the *Dictionary of Economic Products* I have already urged that being a more tropical form, the Malayan plant would very possibly

be found better suited to India than the Chinese. I was not, however, then aware that the Malayan plant was not actually being grown as a fibre crop in India, and my contention in that work was mainly that European planters who may contemplate an extended production should experiment with both forms. It has often been stated that in Europe the clean fibre (China-grass) from China fetched a higher price than the corresponding fibre from India. This was by many supposed to be due to the fact that in India the plant cultivated (as Roxburgh and many subsequent writers had affirmed) was **Bœhmeria tenacissima** and not ***B. nivea.*** We now know, that if the Chinese fibre is actually superior to that obtained from India, that fact must be accounted for by its being supposed that in India the plant does not afford a fibre of the same quality as in China, or that the Indian method of separating and cleaning the fibre is deficient to that pursued in China. In consequence the question of the comparative values of the two fibres is shifted from India to the Malay Archipelago. The companies that have been *announced* as established or very shortly to be established in the Malay would do well to give this subject their careful consideration, and the planters in India who contemplate rhea cultivation have also to solve an important question, *viz.*, which form of the plant gives the best return in adaptation to local climatic and other conditions?

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Comparative Value of both Fibres.
Conf. with para. 31.

Chinese Fibre Superior to the Indian.

34. I shall now attempt to furnish a review of the available information on the subject of Rhea cultivation in India. In doing so I shall first of all give a fairly complete statement (approximately in sequence of date of publication) under a paragraph of reference, of all the more important books, reports and newspaper articles that have appeared and been consulted by me. This may serve the purpose of enabling the reader who may so desire to verify the statements made and to discover whether he is in possession of information not consulted by me. In the second place, I shall take up each province separately, and furnish such particulars as seem of more direct local interest.

Which Form will give best Return in India.

Publications Consulted.

I had hopes of being able to furnish a concluding chapter to this report that might have afforded the means of definite opinions being formed as to the prospects financially of a venture in rhea cultivation. But I have failed absolutely in this expectation. I have been unable to obtain trustworthy data on such all important points as cost of

Financial Prospects.
Conf. with paras. 0, 43, 67, 71, 81, 83, 91, 103, 130, 140.

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production, yield, prices likely to be realized, etc., etc., and therefore to advance personal opinions on the subject of the probable margin of profit, in the absence of definite particulars, seemed to me undesirable.

Character of Indian Cultivation. *Conf. with para. 69.*

35. Rhea cultivation is nowhere pursued in India in more than plots of a few yards in length and breadth, adjoining the homesteads. It receives in such limited cultivation a much larger amount of manure and is more carefully supervised than would be possible with a field crop. The yield varies according to the extent of manure and supervision and so widely that the returns given by one cultivator bear no possible relation to those of another. The fibre is hardly a commercial product. It is grown as a rule by the actual consumer who can with difficulty be induced to put down more than he requires. The price offered has so far failed to tempt an extended cultivation and the labour of separating and of cleaning the fibre have made it very unpopular.

Price does not tempt Extended Cultivation.

COMMERCIAL LITERATURE. *Conf. with paras 12, 25 (for Botanical).*

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BŒHMERIA nivea.

Cultivation of Rhea in India.

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CULTIVATION IN BENGAL.

BENGAL. First Mentioned by Dr. Buchanan-Hamilton.

37. ***History.***—I have already stated that the first authentic record of the cultivation of this plant in Bengal occurs in Dr. Buchanan-Hamilton's *Statistical Account of Dinajpur.* That work was originally written some time between 1807 and 1811. The Government

BENGAL CULTIVATION

had deputed that distinguished scientific author to make a survey of Bengal. During the years mentioned he completed his explorations and wrote reports on—

"Dinajpur, Rungpur, Puraniya, Bhagulpur, Behar and the City of Patna, Shahabad and Gorakhpur. Upon each of the districts he submitted a voluminous report, accompanied with statistical tables, maps and drawings, and where an opportunity was afforded him of collecting it, with collateral information illustrative of the people, or of the geography and natural history of the neighbouring countries." "The original records, occupying twenty-five folio volumes in manuscript, were transmitted by the Indian Government to the Honourable Court of Directors a copy of the whole having been previously made, and deposited in the Office of the Chief Secretary in Calcutta." "It is matter of surprise and regret, that these valuable documents were not given to the public when stamped with the interest of originality and immediate applicability to the actual circumstance of the districts."

Buchanan-Hamilton's Investigations in Bengal.

The above passages have been abstracted from Captain J. D. Herbert's preface to the volume on Dinajpur (published, Baptist Mission Press, Calcutta, 1833) which he undertook to issue in connection with the journal he edited—*Gleanings in Science*. But as no other volumes subsequently appeared, it may be assumed that by far the major portion of Buchanan-Hamilton's great work has been entirely lost.

This digression from the direct history of rhea cultivation in Bengal has been thought desirable in order to convey to the reader, who may not have the privilege of consulting the *Statistical Account of Dinajpur*, some conception of its value and the degree of importance that must of necessity be attached to every word in the passages, devoted to the description of this fibre. Had it been possible to consult Buchanan-Hamilton's account of Rungpur and Bhagulpur there seems little doubt much additional light might have been thrown upon the early history of this Bengal crop.

Buchanan Hamilton's Illustrations of Bengal Plants.

38. In passing I may mention that through the great liberality and kindness of Sir George Birdwood, K.C.S.I., I was presented some few years ago with a manuscript volume of coloured illustrations of Bengal plants. The only date upon the volume is that shown on an index, namely, June 1788. But the scientific names of the plants are, it is believed, in the handwriting of Dr. Buchanan-Hamilton and the vernacular names are those given to the same plants at the

ORIGINAL DISCOVERY.

present day in Bengal only that they are written in Hindi character —a somewhat curious circumstance. Whether the drawings are Dr. Hamilton's own or those of some still more ancient botanist which he had simply named, cannot now be determined; but it may be added that, while many of the plants described in the *Statistical Account of Dinajpur* appear in the volume, there is no illustration of the plant which he calls Urtica nivea, *Willd.* The date on the index (19 years prior to 1807) would of course render that an improbability in any case, but if the manuscript and drawings prepared during his survey of North and Central Bengal could be now procured, much light would very possibly be thrown on this somewhat obscure subject.

Buchanan-Hamilton's Specimens. *Conf. with paras. 22 and 44.*

39. ***Buchanan-Hamilton's Description.***—On page 194 of "*Dinajpur*" the following passage occurs:—

Root Cuttings. *Conf. with paras. 69, 79, 83, 86, 92, 102, 104, 128.*

Steeping in Water. *Conf. with paras. 54, 72, 82, 100.*

"*Kankhura.*—This is a species of Urtica, and perhaps the nivea of Willdenow. I have seen it nowhere else except in this district. It is a woody plant, and its bark is frequently used by fishermen to make a kind of hemp, of which they form the ropes for their nets, and all the ropes used for tracking boats are made of this material. It is propagated by slips from the roots, which are planted out in the beginning of the rainy season. There are no fields of this plant, but many gardens have a few beds. The leaves are used as a green, but are very indifferent, and fresh shoots are cut and steeped in water to procure the fibres of the bark. It is a perennial plant."

Dinajpur Area under Crop in 1807. *Conf. with para. 42.*

Then again under his chapter on Agriculture—*Section 3.—Plants grown for producing thread or cordage,* Dr. Buchanan-Hamilton gives the area in Dinajpur devoted to the four chief fibres as follows:—

"1. *Pat*, Corchorus capsularis	*Bighas*	40,000
"2. Cotton	"	25,000
"3 *Son*, Crotalaria juncea	"	14,000
"4. *Kankhura*, Urtica nivea	"	1,000
TOTAL .	*Bighas*	80,000

Found in Dinajpur only.

There are two points in the above passages that may be specially noticed: Dr. Buchanan-Hamilton says he had seen it nowhere else except in Dinajpur. The shoots were steeped in water to procure the fibre. Both these statements, it will be seen below, are at variance with modern Indian experience.

BENGAL CULTIVATION

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DINAJPUR.

41. *Districts in which Rhea is not Cultivated.*—But to return to the subject of the cultivation of *kankura* in Dinajpur, Dr. Buchanan-Hamilton's statement has been repeated by all subsequent writers, and I regret to say so far distorted by many, as to be spoken of ultimately as an abundant wild plant, extensively cultivated in the district in question.

Distortions of Buchanan-Hamilton's Statements.

On the Government of India directing that I should conduct a personal tour of exploration through the chief districts of Bengal and Assam, in which *kankura* or rhea cultivation was pursued, I addressed a circular letter to the Collectors of the districts in which I thought it very possible the crop might be found. My object was, if possible, to obtain a list of the villages that I might visit in order to study its cultivation. I was much surprised when I obtained the reply from Dinajpur that *kankura* was practically not grown anywhere in that district. In the under-mentioned districts of Bengal rhea or *kankura* is not cultivated by the people: Burdwan, Chittagong, Dacca, Howrah, Hughli, Jessore, Maldah, Midnapur, Murshidabad, Mymensingh, Nadai, Pubna, Purnea, Rajshahi, and Tippera.

Not Cultivated in Southern Districts.

Districts in which Rhea is Cultivated.

DINAJPUR.

Conf. with para. 39.

42. *Dinajpur.*—I visited Dinajpur and made extensive explorations by marching on foot day after day, through the more important agricultural tracts of the district. I nowhere came across either a cultivator who could be said to have had a personal knowledge of the *kankura* plant, nor could I discover a plot of land under the crop, until I had reached the most northern and eastern portions of the district at Birganj, Joyganj and Nawabganj—on the borders of Rungpur and Bogra districts. On one occasion I was informed by the Collector that he had obtained word of what appeared to be the plant in the Southern part of the district and of its existing in a wild state. Before leaving Dinajpur I accordingly took an opportunity of making a special march of 39 miles from Akkelpur to Sonai and Patintola in order to see this reputed wild *kankura*. But on arrival I was grievously disappointed on being taken to a small deserted field and ruined village site, lying between extensive jute tracts, in order to be shown a few plants of Hibiscus Abelmoschus, which the owner called *kankura*. These were certainly not wild though they were not exactly cultivated, but the fibre, I was assured, was regularly made from the stems and used for fishing lines.

Confined to the most Northern Parts of Dinajpur.

Report of Wild Kankura.

Conf. with paras. 6-7, 41, 44, 52, 60.

BŒHMERIA nivea. | Districts in which Rhea is Cultivated.

BENGAL CULTIVATION

March through Jungle Tracts.

On another occasion I marched from the saddar station of Dinajpur to Joyganj and Gopalpur through a rich fertile country, every village for considerable distances off the main road being carefully examined for, and the cultivators questioned regarding their knowledge of *kankura*. A portion of this long and somewhat tedious march of five days' duration was through the wild scrubby jungles that now represent the once tiger-infested forest of which Dr. Buchanan-Hamilton has so much to say. No better opportunity could have been afforded me of testing the question whether the plant existed in a wild state in Dinajpur. The tall trees that once flourished have disappeared, but bushes some six to fifteen or twenty feet in height cover the tract and would afford the shade that rhea is universally said to seek, while the soil is a sandy loam on which one would have expected to find the plant. These uncultivated expanses were explored with the utmost care, but no trace of Bœhmeria nivea could be found.

Is not Wild. *Conf. with paras. 6-7, 17, 28, 30, 32, 41, 44, 52, 60, 76, 77, 83, 105, 128, 194, 197.*

Experiment of Rhea Cultivation.

43. At Joyganj I was informed the late Rajah Syama Sankar Roy, Bahadur, was induced some fourteen years ago to experiment with the cultivation of rhea. He laid out several plots of high land, in the aggregate coming to something like 600 acres, and placed Mr. Gow Smith in charge of the plantation. Great difficulty was experienced in procuring stock. Plants could not be obtained in the Dinajpur district and the cultivators in Kaunia in Rungpur demanded such high prices that roots had ultimately to be procured from the Calcutta and Saharanpur Botanic Gardens. No particulars had been preserved in the Rajah's Office of the results obtained, and the present owners of the estate could, therefore, afford me no definite information except that the plants grew remarkably well and gave three and sometimes four cuttings of stems a year. The experiment had to be abandoned as the price offered for the ribbons of bark was not equal to actual cost of production, and also because no machine had been found that could economically separate and clean the fibre. I personally inspected one of the plots of land used in this experiment, *viz.*, at Joyganj itself. It was on the bank of the river, but above inundation level. It has not since been cultivated but, though I looked everywhere, I could neither find on the neglected plantation, nor in the neighbouring jungles, any trace of Bœhmeria nivea. On mentioning this fact to my friend Babu Pran Sankar

Was Abandoned Because it did not Pay.

Plant has not Survived in the Jungles. *Conf. with paras. 18, 28, 29, 60, 115.*

Roy Chandhurie, part owner of the estates and brother of the late Rajah, he said he could show me one plant that had survived in a neglected corner of his flower garden. This I examined and found *typical* **Bœhmeria nivea,** but I venture to think that the entire disappearance of many thousand roots in fourteen years, fully disposes of the report of the plant being a native of this part of Bengal.

RUNGPUR.

44. ***Migration of the Plant.***—Here then we have another of the many perplexities that beset the study of rhea cultivation in India. The plant is certainly not wild and practically is not even cultivated in Dinajpur. How are we then to account for the abandonment of the 1,000 *bighas* which Dr. Buchanan-Hamilton established as the area under the crop in *1807?* The cultivation of the crop must either have been entirely discontinued, or the area assigned to the district during the beginning of the century must have embraced a considerable portion of what is at present designated Rungpur. The latter explanation may possibly be the correct one, but I am assured by the Collectors of both districts that there are no records to show any such re-arrangements. On the other hand, there seems no doubt that a change has come over the district of Dinajpur since the date of Buchanan-Hamilton's explorations, and of so revolutionary a nature that it would be no great stretch of imagination to suppose the crop to have been swept away by the modern wave of popularity for jute cultivation. Of one point we may feel certain as indicative of change, *viz*, that whereas Buchanan-Hamilton found the *kankura* nowhere else except in Dinajpur, its cultivation has extended North and East into Rungpur, Jalpaiguri and Bogra

Is not Wild.
Conf. with paras. 6-7, 17, 28, 30, 32, 42, 52.

Cultivation Abandoned.
Conf. with para. 39.

Revolution in the Agriculture of Dinajpur.

But, when it is recollected that there has been considerable confusion in the botanical identification of the plant, and that the supposition has had to be accepted that so accurate a botanist as Roxburgh may have failed to recognise the isolation of the Sumatran from the Chinese (and Rungpur) plant, the suggestion naturally occurs, is there any very strong evidence to show that the plant grown in Rungpur to-day is botanically the same as that found by Buchanan-Hamilton in Dinajpur at the beginning of the century? But let me add, Roxburgh never speaks of the plant as having been supplied to him from Dinajpur but from Rungpur*—the district in which Dr. Campbell

Was Roxburgh Right after all?

* Consult foot-note to para. 22.

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Goalpara. *Conf. with para. 53.*

RUNGPUR.

Lesson to be Learned from Tobacco Cultivation.

High Class Agriculture.

Tobacco Trade: Burmese Supply.

Trade in Ginger.

Rhea has to Compete with Tobacco and Ginger.

subsequently found it being cultivated—and Hamilton's specimen in the Edinburgh Herbarium would appear to have been obtained from Goalpara, not Dinajpur. According to Mr. Monahan rhea is not cultivated in *Goalpara* at the present time, so that here again we have a further possible evidence of change.

45. *Rungpur.*—One of the most striking features of this district is the extent of tobacco cultivation. Both **Nicotiana Tabacum** and **N. rustica** are grown wherever the soil is a rich sandy loam with water only a few feet below the surface. Wells are dug all over the tobacco fields, and during certain stages in the crop hand irrigation is daily pursued. In fact the water is thrown from the wells so as not merely to supply moisture to the roots, but to wash the dust off the leaves. The agricultural system pursued by these cultivators is of a very high order, and it is not to be wondered at, therefore, that the exports of cured tobacco leaf should be, as I was informed, valued at over R10,00,000. But a further circumstance may be here mentioned; practically the whole exports are purchased by Burmans who have settled in the district. The cultivators sell their leaf on the field to tobacco curers who are all up-country traders or *Dalals* and the latter sell to the Burman dealers. The leaf is then sent to Burma to be made into cigars. Only the tobacco of first quality is bought by these dealers, so that the superiority of the Rungpur leaf over that of the rest of Bengal has given origin to the distant industry of manufacturing cigars in Rangoon and Moulmein, a large proportion of which returns to India again to meet the growing demand for Burman cigars. In addition to tobacco Rungpur also produces a large amount of ginger of a very fine quality.

46. The Railway to Jatrapur may be said to cut the district practically in two and curiously enough on the one (the northern) side, **Nicotiana Tabacum** is extensively grown, while, on the other, **N. rustica** is very frequently met with, especially in all the low-lying undulations of the soil. But wherever the red clay soil appears tobacco cultivation at once disappears.

Rhea seems to flourish exclusively within the tobacco-growing portions of the district and the plant is most successfully grown where the finer qualities of **N. Tabacum** are produced. I have mentioned these particulars of tobacco cultivation in order to

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pointedly draw attention to the fact that rhea is by no means a plant that can be produced on any soil or under careless and neglectful agriculture. It demands the best soils; the land must be above inundation, but possessed of free sub-soil moisture; the fields have, moreover, to be manured and carefully tended. When such conditions are forthcoming it luxuriates, but without them it is a failure. My experience points directly therefore to localities and soils that are suitable for tobacco as being very possibly suitable also for rhea.

Demands Careful Cultivation. *Conf. with paras. 41, 53, 67-81, 79, 83, &c.*

Dr. Campbell wrote of the cultivation of this plant in Rungpur in 1847. He says—

"In the month of January last, when I was returning from the Bhootan frontier through the district of Rungpur, my attention was attracted by small patches of green crop, cultivated, with much care, close to the villages along the banks of the Teesta River I had never seen the plant before, in that part of the country it was an object of additional interest. It turned out to be the *kankura*, and is considered by the people to be a species of hemp. It is cultivated with much care."

Dr. Campbell's Experience of Rhea in 1847. *Conf. with paras. 19, 213.*

Thus 40 years after the date of Buchanan-Hamilton's exploration rhea cultivation had been fully established in Rungpur.

47. During my explorations in the Rungpur district I visited so many rhea-cultivating villages that a mere enumeration of these would take up much space and serve no very useful purpose. Around the suburbs of Rungpur itself I found the plant grown here and there, and the following villages may be specially mentioned; Rampura, Satgara, Lalbag, Barabari, Bororghat, Shabda, Shabdapuskerni, and Shampur. A little further afield Ablihat, Burirhat, Jhotaka (30 miles from the town of Rungpur). The village of Kankurapara (in the Kurigaon sub-division) receives its name on account of the extent to which *kankura* is cultivated. There were in that village when I visited it at least 20 cultivators, none of whom belonged to the fishing class. They grow the plant and sell the produce on the field to the fishermen. The plots of land devoted by each cultivator to the crop approximate to what might be called field cultivation. *Kankura* in this sub-division might in fact be regarded as a regular agricultural crop, a state of affairs seen for the first time at Kankurapara, and nowhere else met with on the same scale in my subsequent explorations in Bengal or Assam. At Honnaram near Barabari, cultivation on a fairly large scale was also found, but the plant was reported to be liable to the attacks of a caterpillar that did much

Explorations Conducted by Me.

Extensive Cultivation.

Cultivators not Fishermen. *Conf. with Paras. 79, 82, 90.*

Kankurapara.

Attacked by Caterpillar. *Conf. with para. 71.*

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injury. The cultivators were *Rajbunsis* who sold the produce to the fishermen.

Garo Hills.

48. Crossing the Brahmaputra River to the corner of the Rungpur district that lies just under the Garo Hills, the crop was met with at many villages around Rohmari but, though the neighbouring extensive flat jungles were explored and for some distance up the slopes of the outer hills as well, no trace of wild Bœhmeria nivea was met with, nor had the people any knowledge of its being a wild plant.

Soil.
Conf with paras. 46, 50, 62, 78, 91, 111, 150, 175, 187, 210.

Garden Cultivation.
Conf. with paras. 7, 35, 39, 47, 49, 65, 101, 103.

49. *Soil Required.*—The villages mentioned will serve to indicate that the greater part of Rungpur was visited, and it may be added that the rule already laid down was confirmed on all hands, namely, that wherever a soil of rich sandy loam occurred, there *kankura* cultivation was met with. With the exception of the localities mentioned (in the Kurigaon sub-division), it was, however, exclusively found in small plots around the homesteads and mainly grown by the fishing class for their own use and not as an article of trade.

BOGRA.

50 *Bogra.*—Having explored the tract of Rungpur and a portion of Goalpara that skirts the foot of the Garo Hills, I recrossed the Brahmaputra and entered the district of Bogra at Jumarbari and marched to Modhupur, Mokamtola and thence to Bogra Station. Having visited many villages *en route* where rhea was being cultivated (and which is here called *kund*) I next explored the neighbourhood of Bogra itself and worked my way back again to the river at Nokhi'a, as I was assured the whole country on the other side of the district (west and north toward the railway) had a red clay soil and no rhea cultivation. I was much struck with a change in the agriculture of the alluvial tracts of this district. Tobacco had to a large extent disappeared and its place been taken by extensive fields of Capsicum frutescens (chillies) and Ipomæa Batatas (the sweet potato). I had never seen either of these as field crops before and was greatly pleased with the red chillies since they gave a bright effect to the otherwise monotonous scenery. With the disappearance of tobacco, rhea cultivation became scarce and of a very indifferent quality. On nearing the border line of the alluvial and red clay soils both crops were ultimately lost and their places taken by the elevated narrow fields (or rather ridges) on which the mulberry is cultivated.

Local Name *Kund.*

Rhea will not Grow on Red Clay.

Chillies and Sweet Potatoes.

Mulberry Beds.

51. The only point of additional information learned in Bogra regarding rhea was in connection with the cleaning of the fibre. The samples of clean fibre shown to me were of a rich golden yellow colour. On enquiring the reason I was informed that the dry fibre after being stripped from the stems is at once dipped into a boiling solution of *haldi* (turmeric) for a few minutes. This was said to soften the fibre very greatly and to thus assist in the cleaning process.

JALPAIGURI.

Fibre Cleaning Chemicals.

Conf. with paras 51, 54, 72, 73, 80, 164, 209.

52. ***Jalpaiguri.***—Taking train from Kurigaon I proceeded to Jalpaiguri. From there I skirted the Duars and marched to Falakata, thence to Alipore and Kuch Behar, a distance of 84 miles. On that route many rhea-growing villages were visited and occasionally the plant was found to receive the name of *kurkund* not *kankura*. Very little additional information was, however, obtained. Everywhere it was grown around the homesteads. On the banks of the Teesta few, if any, fishermen's house could be found without its small plot of this plant. The road led through extensive jungle tracts, but though constantly searched for, not a trace of **B. nivea** could be found in a wild state. On one occasion a cultivator told me that he had seen it wild at a certain village. A detour was at once made of some miles off the route only to be once more disappointed. The plant was **B. platyphylla**, which the cultivators assured me, though now wild, had been grown on account of its fibre, and that the fibre, while inferior to the *kankura*, was a good one for fishing lines and nets.

Local Name Kurkund.

Not Found Wild.

Conf. with paras 6-7, 41, 42, 44, 60.

53. ***Kuch Behar and Bhutan.***—The jungles that skirt the foot of the Bhutan Hills were examined as far as time would admit, but with the same result, **B. nivea** was not found wild, though in the villages here and there, the usual small plots near the houses occurred. In Kuch Behar a good deal of rhea was also met with, one or two fields being within the town itself. But the following statement occurs in an official letter (*No. 204, dated 2nd August 1870*), "A plant supposed to be rhea grows wild in the hills of Darjeeling, Goalpara, and probably throughout the Duars of Bhutan, and can be propagated, it is believed, to any extent." Whatever may have been meant by the above it was not rhea, at least I have no hesitation in saying so from my personal explorations of the greater portion of the regions mentioned. I have never in all my ramblings, which have extended now

KUCH BEHAR.

Goalpara.

Conf. with paras 22, 44, 60.

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for over 25 years, come across a wild plant of **B. nivea.** But Mr. Monahan in his *Note on Rhea Cultivation in Assam* says that the plant is not met with at all in the Goalpara district. I have not personally visited Goalpara, but there seems no sufficient reason for thinking that it should not occur since it is cultivated in Kuch Behar and Kamrup—on both sides of Goalpara. The distribution of the plant is, however, very erratic, and it is probable Mr. Monahan may be correct though the circumstance is certainly very peculiar.

54. ***Other Districts of Bengal—Bhagalpur*** is mentioned by writers on rhea, but I have not been able to visit it in connection with this enquiry. Among the papers put up by Government in 1879-80 for the guidance of the Commissioners appointed to examine and report on the rhea fibre-extracting tests at Saharanpur, mention is made of the district of Bhagalpur. Colonel H. H. Stansfield, Private Secretary to His Honour the Lieutenant-Governor, wrote:—

Fibre Prepared many years ago.

"It may be of interest to His Honour to know that the fibre has been prepared many years ago at Bhagalpur by some families of the Dhanook caste for the silk weavers there." So again it is stated by Messrs. Thomson and Mylne (*letter 20th September 1879*): "The method for obtaining the fibre practised by certain natives of Bhagalpur of the Dhanook caste, some eight or ten years or still further back, is generally as follows:—

Mixed with Silk. *Conf. with paras. 14, 201.*

"The site of the little factory is chosen, if possible, near a stream of soft water, as the process is one of slow boiling or simmering, and beating in combination with washing.

Method of Cleaning Fibre. *Conf. with paras. 51, 72, 164.*

"The factory plant is an earthen or other pan or boiler, and two notched boards such as dhobies use.

"The work people, two men, two women, and two boys.

"The boiler is charged with water sufficient to cover the shoots proposed to be dealt with, and to it is added about 10 chuttacks *sujjee matee* (crude carbonate of soda) per maund of plant placed in the boiler, the whole is then allowed to simmer or boil slowly for 1½ or two hours.

Boiled in Carbonate of Soda.

"The shoots are then taken by or handed to the nearest man with a notched board before him, (the boards being placed near by or partially in the water *dhobie* fashion) in such portions as can be held firmly between his two hands he continues to dash it against the board washing it at the same time, thus clearing each end alternately of the wood and portions of the bark and gum. The handful is then passed on to the second man with a similar board who beats and washes it in the same way to free the filaments still farther from gum and bark.

Beaten on Boards under Water. *Conf. with paras. 100, 167.*

"After this it is taken by the boys back to the boiler to be again slowly boiled or simmered for about an hour. It is then again beaten and

Boiled a Second Time.

washed by the two men as before till the gum is removed, and the filaments are free.

SUNDERBANDS.

"The two women now take charge of it to be dried, beaten and drawn or carded till it is in the condition of the accompanying sample but much whiter.

Carded.

"A maund of shoots per hour can thus be easily worked off, which, if filament is in the plant in the proportion of 2½ per cent, will be one seer of fibre fit for the spinning by the native hand method or for carding machine if sent to Europe. If the percentage of filament in the plant is over 2½ per cent., the outturn will be increased in proportion while no addition is made to the cost.

One maund (80 lbs) an hour can be Cleaned.

"By adding half the original quantity of *sujjee matee* to hot water in the boiler it may be used again afterwards, the water should be changed" (*Jour. Agri.-Hort Soc. Ind* (*n.s.*) *VI.*, *172.*)

55. I have not been able to discover whether the fibre is still being cultivated in Bhagalpur, but Mr. T. Sandys in a letter to the Bengal Government would seem to throw some doubt on the accuracy of the information. "I beg to state," he says, "that I know nothing of the Dhanook party, now said to have removed to Synthia." He then goes on to explain that he obtained the stock of plants cultivated by him from "Chowringhee, Purneah, Dinajpur and Rungpur." So far as my investigations go rhea does not occur in Purneah at all—or rather it is not grown by the Natives—and it is only met with in a few villages in the extreme north corner of Dinajpur, that might more properly be described as Rungpur. But Mr. Sandys' experience in the cultivation of the plant is in full accord with all I have written and may be here quoted :—

Mr. T. Sandys' Experiments.

Experience in Cultivation.

"I have met with great reverses in the cultivation, the difficulties of which I regard as secondary if not equal to those for the extraction of the fibre. Nothing but the highest state of garden cultivation will answer. Will this pay? I think it will, provided that an economic organised system is pursued from the planting of the cuttings until the fibre is woven into cloth, or otherwise. I cannot speak positively on this point, as it has not been worth my while to try it as yet on a proper scale." "Rhea from the character of the plant must be grown on high lands in contradistinction to submerged lands"

High Garden Cultivation Essential.

Conf. with paras. 48, 50, 62-4, 83.

Mr. T. Sandys' further remarks on the danger of white-ants are well worthy of careful consideration. He says:—

White Ants an Enemy to Rhea.

Conf. with Report, Tea Pests and Blights, pp. 340-369.

"After harvest cuttings they (white-ants) attacked the woody portions of the stem, thus left exposed, and burrowed downwards inside the roots

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completely honeycombing them of their pith, leaving nothing but the bark untouched. They eventually attacked all weaker plants of all ages." (*Jour. l.c., pp. 175-6.*)

In an official communication (*No. 204, dated 2nd August 1870*) it stated, "The Rhea plant is not indigenous to any part of this district. It can, however, be grown everywhere with more or less cultivation."

But with these statements of a more or less ancient cultivation and of a use for the fibre in admixture with silk before one, it is difficult to see how so careful an investigator as Dr. Buchanan-Hamilton could have said that he had met with the plant in Dinajpur only. We are, I venture to think, forced to believe that the Bhagalpur Industry may have been very recent, and perhaps only temporary, if not instituted by Europeans. But as I have not visited Bhagalpur, I must allow this somewhat conflicting statement to stand side by side until more definite particulars are forthcoming.

Sunderbands.

56. *Sunderbands.*—"The Rhea plant is unknown here, except in Messrs. Morrell's estate in the Jessore portion." "Mr. Clarke, Superintendent of the Botanic Gardens, feels pretty sure that the plant is not to be found in the Sunderbands *wild*" The above has been taken from an official report dating back to 1870. Personally I have botanised over a good portion of the Sunderbands (*e.g.*, Khulna, Backergunge and Noakhali), and I certainly never came across the plant, either wild or under cultivation. The water-logged nature of the sub-soil for a great part of the year would seem to render this area a most unlikely one for a future Rhea industry. I visited Messrs. Morrell & Co.'s estate, but their present manager assured me the experiment had long since been abandoned.

Patna.

57. *Patna.*—The Commissioner wrote (*No. 287, dated 6th August 1870*) that "the plant does not grow in any district of Patna. Any profitable culture is precluded by the general dryness of the soil and unsuitableness of the climate."

Orissa.

58. *Orissa.*—The plant is stated to be unknown.

CONCLUSIONS

Recapitulation of Conclusions Regarding Rhea in Bengal.

59. Having thus briefly indicated the extent of my personal investigations into the *kankura* districts of North Bengal, and given a few passages to show the practical absence from the other districts and divisions of the Province, I shall now endeavour to bring

together a few of the more instructive facts thus brought out, of a practical nature, regarding the cultivation of the plant. The following may be admitted as fully substantiated:—

CONCLUSIONS

Important Fact Regarding Bengal Rhea.

Is not Indigenous.
Conf. with paras 6-7, 41, 42, 44, 52, 77.

60. ***Is not Indigenous.***—The plant is not a native of the districts of North Bengal Its acclimatisation has not been carried to the extent of the plant having found its way into the jungles as a weed. From abandoned cultivations it is rapidly exterminated by the indigenous weeds. (*Conf. with paras. 18, 23, 29, 43.*)

Restricted Area.
Conf. with paras. 42-58.

61. ***Local Peculiarities.***—Its restriction as a fibre crop to certain districts of North Bengal, points to the existence in these of favourable conditions very possibly not present in the greater part of the rest of the province. But its profitable production as a commercial fibre is not even possible within every part of the districts where its cultivation is pursued

Soil.
Conf. with paras. 46, 49, 50, 91.

62. ***Soil Required.***—It requires a rich alluvial soil (a sandy loam) and cannot be profitably grown on clayey soils, nor on inundated tracts such as are suited for rice and jute.

Cultivation Limited.

63. ***Limited Cultivation.***—But the fact that it is not universally grown by the fishermen throughout India on the alluvial basins of all rivers, points conclusively to the necessity for other conditions than merely a rich soil of sandy loam. Even within Rungpur, which may be regarded as the head-quarters of the Rhea production of India, there are large tracts to the south where the people admit freely that the plant cannot be profitably cultivated, or where only a very inferior fibre can be produced

Conditions.
Conf. with paras. 45-46, 55, 83.

64. ***Conditions of Cultivation.***—It commands the finest lands; a liberal sub-soil moisture or extensive irrigation; the greatest possible attention and protection from cattle; a high amount of manure; and, while given all these conditions, the plant will produce an abundant crop; the fibre is troublesome to separate and the crop accordingly unpopular

Expansion.
Conf. with paras. 45-46, 50.

Price.
Conf. with paras. 3, 4, 9, 43, 81, 83, 84, 136.

65. ***Possible Expansion.***—Rhea has to compete with tobacco, ginger, capsicum, and other such highly profitable and convenient crops, and the land suitable for its cultivation is already very largely occupied and would be expensive. Unless, therefore, a great reduction in cost of cleaning the fibre or a much higher price can be secured for the article than at present, there would seem little prospect of the native cultivation being materially extended, or of Rhea

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production becoming a remunerative occupation for European labour and capital

Direction. *Conf. with paras. 17, 30, 90, 94, 189 (4).*

66 ***Probable Direction of Expansion.***—The most hopeful prospect of a future expansion may be said to lie within its present area in North Bengal. The overflow might then be looked for to pass east and north-east into the valley of Assam rather than to go to the southern and south-western or south-eastern districts of Bengal. In fact it would almost appear as if there had been a migration north-east since the date of Buchanan-Hamilton's explorations in 1807. Its suitability to the Rungpur and Jalpaiguri districts and to the Duars would point, however, to a possible expansion westwards toward Tirhut. In other words, it would almost seem as if the Indian Rhea cultivation might become distributed within the belt of districts which, starting in the extreme east-north-east in Lakhimpur and passing through Sibsagar, Darrang, Nowgong, Kamrup, Goalpara, Kuch Behar, Rungpur, Jalpaiguri and the northern extremity of Dinajpur, passes still west to Purneah, Bhagalpur, Durbhanga, Muzafferpur, Champaran, and possibly also to Saran. The sub-montane character of this tract of country, skirting as it does the foot of the Bhutan, Sikkim and Nepal Himálaya, may be at once admitted as very possibly possessing many physical and meteorological characters in common It may be said to lie between 25° 30′ and 27° north latitude. But how far a western expansion may be possible the future alone can reveal; no difficulty would seem to exist against an eastern distribution except perhaps the labour question which is so very serious in Assam.

Sub-montane Tract.

Latitudes of Rhea Cultivation. *Conf. with paras. 133-4, 189 (4).*

Rungpur lies right in the centre of the region indicated, and, as already stated, the crop was found to attain its greatest perfection on the north and the north-eastern divisions of that district—the portions that may be said to face eastwards toward the Brahmaputra valley.

Expansion to the South improbable.

67. ***Southern Districts Unfavourable.***—In Bogra the crop could alone be said to be important in the nothern and north-eastern portions. The clay, rice lands, to the south and west, *viz*, those that adjoin Dinajpur and the Rajshahi, were found to contain no Rhea. So in a like manner in Dinajpur itself only the most northern extremity of the district, *viz*, that portion which adjoins Rungpur or penetrates between Jalpaiguri and Purneah, could be said to have Rhea

B. 576-606.

CONCLUSIONS.

Vegetation of the Sub-montane Region of Rhea.

68. ***Vegetation of Rhea Area.***—It would very possibly detract from the prominence I desire to give to the fact that Rhea cultivation is confined within the belt of sub-montane districts indicated, were I to attempt to furnish a full statement of the characteristic features of the vegetation of that country. I shall therefore confine myself to a few of the more significant points that seem to me to be very possibly due to the same causes that give a special adaptability for Rhea cultivation. After crossing the Ganges at Saraghat the visitor to North Bengal would very possibly be at once struck with the rapid disappearance of the distorted thorny trees of *babul* (**Acacia arabica**) that are so very characteristic of the southern districts of the Province. At first they are seen only here and there until a point that corresponds with the middle of Dinajpur is reached when they practically disappear. The *babul* belongs to the great Natural Order of **Leguminosæ**, a group of plants that includes the vetches, peas and beans On directing attention to the fields within the area of Rhea cultivation, it will be seen that with the exception of **Crotalaria juncea** (*Sann* Hemp) there are remarkably few leguminous crops. The people of North Bengal accordingly use a very much smaller amount of pulses in their daily diet than do the people of the rest of Bengal But they make up for this defect by the consumption of a very much more varied series of *sags*, or green vegetables As Buchanan-Hamilton has told us, they eat the leaves of the Rhea plant itself, and, I may add, they regard its abortive flowering spikes as a great delicacy, and these in point of flavour are said to resemble the cauliflower.

Distribution of the *Babul* Tree.

Few Leguminous Crops.

Every cultivator has what might be called a vegetable and fruit garden—a state of affairs hardly met with in any other part of India. And what is most significant these enclosures around the houses contain an assemblage of plants peculiar and characteristic to the rhea area. I shall mention the more striking examples of green vegetables by way of illustration and in order of abundance:—

Gardens Around the Homesteads.

1. **Malva verticillata**, *L.* This mallow is universally grown from Rungpur, Jalpaiguri and Kuch Behar to Upper Assam, and even finds a place in the vegetable gardens of Europeans. It is known as *lapha sag* and the leaves are eaten.

Mallow.

2. **Chrysanthemum coronarium**, *Linn* This very elegant yellow flowered **Chrysanthemum** is universally grown as a vegetable. Botanists tell us it is a native of the Mediterranean region, but

Chrysanthemum.

BŒHMERIA nivea. | Method of Cultivation.

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every cultivator knows it by the name *babir*. I have never seen this in any other part of India, and it is perhaps the most striking plant of the region.

Sorrel.

3 **Rumex vesicarius,** *Linn.* While this sorrel occurs here and there very occasionally in gardens to the south of the region indicated, it is so very abundant and in such frequent association with the others, that it may be specially mentioned in this connection. It is an extremely handsome plant and should find a place in ornamental flower gardens even if its merits as a green vegetable do not commend it to consideration.

Buckwheat.

4 **Fagopyrum esculentum,** *Moench.* This plant instead of being grown for its seed (buckwheat) is raised as a vegetable. It is most generally known as *phaphra* and in Assam as *doron.*

Chinese Cabbage.

5. **Brassica (Sinapis) cuneifolia,** *Roxb.* In nearly every one of these vegetable gardens, specially in Assam, a species of **Brassica** is grown as a vegetable. This has a rosette of ground leaves generally of a dark bluish-green colour and with very broad yellow mid-ribs and leaf stalks. When young it looks not unlike a cabbage and is, I presume, not very remote botanically from Chinese cabbage In time it shoots up a much-branched inflorescence to a height of four to six feet. This becomes clothed with numerous sessile (stalkless) leaves All parts are eaten, more especially the young flowering shoots, with their delicate leaves

This plant seems to have escaped the consideration of economic botanists and gardeners alike. It is one of the most significant and elegant of vegetables and there are probably several easily recognisable forms. At all events I found some with glaucous leaves covered with a white waxy powder and others pale-green and devoid of the waxy coating. It is generally known as *lai-hak* which might be translated mustard-*sag e.i.* vegetable

Lai hak.

It would occupy too much space to develop this list further, but let me add there are just as many significant features in the wild vegetation of the rhea area, as in its field and garden crops My present purpose has been served by the above brief notes, namely, the exemplification of striking peculiarities sufficiently marked to justify the conclusion that there are present conditions and peculiarities that very possibly are intimately associated with the restriction of successful cultivation of rhea to the tract of country I have indicated.

Wild Plants of the Region.

69. ***Method of Cultivation.***—In Bengal rhea is propagated by root cuttings, though the system of burying horizontally stem cuttings is sometimes pursued, more especially to fill up vacancies and to increase the number of plants in the fields The cuttings are usually 6 to 9 inches in length and planted under 3 to 4 inches of soil. They are placed from 1 to 3 feet apart each way. There are said to be two seasons for transplanting, the *first* in April to May (before the commencement of the rains), and the *second* in September to October (at the close of the rains). The majority of cultivators seemed to favour the former season

CONCLUSIONS

Methods of Cultivation.
Conf. with paras. 35, 91.

Seasons.
Conf. with paras 86, 92, 96.

The fields are weeded and hoed after each cutting and heavily manured every year during the cold season. Unless very heavily manured, the plants should be transplanted into new plots of land after two, three, or four years, depending on the fertility of the soil.

Weeding and Hoeing.
Conf. with para. 97.

70. ***Number of Cuttings.***—The shoots are cut down when the bottom portion of the stem begins to turn of a brown colour. At this stage the leaves, low down on the stem, also begin to fall off. Two to four or even five cuttings are obtained a year, the shoots being from four to five feet in height. The majority of cultivators gave three cuttings as a good average crop Two cuttings they regarded as indicative of neglectful cultivation, and five or six they said can only be obtained from very small plots shaded, heavily manured, and freely watered As a rule the entire plot is cut down at one and the same time, but occasionally the more intelligent cultivators remarked that they select the stems when ripe and thus practically only cut small quantities at a time but throughout the year.

Length of Shoots.
Conf. with paras. 79, 83, 93, 100, 101, 143, 153, 168.

Number of Cuttings.
Conf. with paras. 79, 86, 96.

From September transplanted plots, the following were given as the season for cutting:—

1st Cutting in May (the worst cutting). 2nd Cutting in June (the best cutting) 3rd Cutting in July. 4th Cutting in August.

Chief Seasons.

But many cultivators seemed to prefer to reject the May cutting and to use it for green manuring the plot, thus having only three cuttings.

Green Manuring.
Conf. with Paras. 86, 100.

If transplantation takes place in April-May there are usually only the three cuttings those already indicated A cutting made later than August is regarded as affording a very inferior fibre. Many cultivators nevertheless cut down the plants once or twice during the cold season but with a view to cause a vigorous shooting simultaneously for the June cutting

BŒHMERIA nivea.

Price of Fibre.

BENGAL CULTIVATION
Outturn.

71. ***Outturn and Cost of Production.***—So contradictory were the figures furnished from day to day by the cultivators, that I gave it up as hopeless to attempt to form any definite conclusions. It seemed to me that the only satisfactory way to arrive at opinions that could with any degree of assurance be given to the public, would be for the Government, without any warning, to arbitrarily purchase (and preferably in the Kurigaon sub-division of Rungpur) the crop as found on two or three plots in various villages at each of the above seasons and to reap the stems at once and separate the fibre by machinery or otherwise. Were careful returns preserved of the sizes of each plot (if not of the actual number of plants as well), the weight of the green stems, and the weight of the clean dry fibre or of the ribbons, it might be possible to form an opinion as to the yield per acre. One of my Bengali assistants, during our tour through the rhea districts of the province, made careful enquiries at one or two villages and he gives me the following as the result. I publish his conclusions mainly with the object of showing the value, if any, that can be placed on all such returns:—

Yield.
Conf. with paras. 79-80, 81, 83, 85, 96, 99-100.

"The only information I could get about it from two rhea fields at a village near Barobari, in Rungpur, is given below. The cultivator, Sukalu Das, obtains 32 seers (60 tolas = 1 seer) of fibre a year from a plot of land which estimated at the acre would produce 6 maunds, 21 seers (80 tolas = 1 seer), or 535lb. Another cultivator, named Maniram Das, obtains 15 seers (60 tolas = 1 seer) of fibre from a plot of the area of 165 square yards. Therefore 1 acre of land would yield 7 maunds, 5 seers (80 tolas = 1 seer), or 584lb. Even these quantities would only be available if the fields are well treated. A well-cared-for plantation may last for several years—'for ever,' said one of the best cultivators.

Diseases.
Conf. with para. 41.

"Rhea fields are liable to the attack of a kind of caterpillar which eats through the roots of the plants. This caterpillar is called by the cultivators of Rungpur *malpota*. The *malpoka* causes so serious damage to the plantation that the plants wither away within a year or two. When this pest is noticed, the roots of the fields are transplanted. New plantations, it is said, would get on well for three or four years.

Prices.
Conf. with paras. 3, 4, 9, 41, 65, 81, 82, 84, 101, 120, 140

"The price of the fibre in Jalpaiguri is R1 to R1-8-0 per seer (80 tolas = 1 seer), in Rungpur and Bogra R1 to R2-8-0 per seer (60 tolas = 1 seer). Thus 1 acre of land would produce about 250 to nearly 400 or at most 650 rupees worth of fibre per annum according as it was valued at R1 or R1-8 or R2-8 a seer. In the English market the rhea fibre may be sold at £50 a ton (*vide* Dictionary of Economic

Products of India, article on Bœhmeria nivea), or about 6 annas a pound, which is much less than the price in North Bengal.

CONCLUSIONS.

"It was found impossible to get information about the cost of production. I was told by the best cultivators that they might gain a little if the cost of labour for separating fibre could be reduced. It is said that one man can hardly manage to cultivate more than 230 square yards of land. If so, 21 men would be required for the plantation of 1 acre of land. The wages for 21 men for one year would exceed R1,000. My conclusion shows that the value of the estimated outturn of an acre of land is less, by far, than the estimated cost for production. But, in my humble opinion, the number of men stated, is likely to be required only for the occasional operation of separating fibre."

Cost of Production. *Conf. with paras. 34, 81, 85, 87.*

Expense of Production.

72. ***Separation of the Fibre.***—It is customary to wait for the appearance of fine weather before cutting the crop. The stems require to go through a process of drying, and rainy weather or even cloudy days during the drying stage are supposed to injure the fibre. The shoots are at once stripped of their leaves and the leaves very generally returned to the field as manure. The shoots are then carried to the dwellings of the cultivators and by means of a bamboo knife or scraper are deprived of the bark and the green succulent outer tissue around the fibre. It is regarded as essential that all the plants should be scraped or decorticated within 24 hours after being cut. The stalks are then laid out on the ground in some dry situation and exposed to the sun during day and removed within doors at night to avoid the dews, and this method of drying is continued for some 4 to 10 days. The stems are thus completely dried and the adhering fibre more or less bleached. The stems are then each broken across, a little below the middle. The finger or scraper is then inserted underneath and is run upwards and downwards until the whole of the fibre is removed. For this purpose the central stem may have to be broken more than once.

Separation of Fibre. *Conf. with paras. 51, 54.*

Stems Scraped. *Conf. with para. 79.*

Drying the Stems. *Conf. with paras. 79, 80, 86, 100.*

Cleaning the Fibre.

This stage is considered the most troublesome of all. After being removed from the stem, the fibre is once or twice drawn rapidly through between the scraper and the flat surface of the fore-finger, in order to free it from any adhering particles of the stem or bark. But the shoots are in no way subjected to steeping as stated by Dr. Buchanan-Hamilton. The process seen by me in Bengal is in substance that briefly stated by Buchanan-Hamilton (*para. 39*) except in the matter of steeping. The after cleaning of the fibre, preparatory

BŒHMERIA nivea. | Industrial Uses.

BENGAL CULTIVATION

Chemicals not Used.

to its being spun into thread, is done for the most part by the women and children and consists entirely in cleaning and splitting up the fibre by means of the fingers. The system of boiling in *sujjee matee* (or crude carbonate of soda) described above in connection with Bhagalpur (*para* 54) I nowhere found being followed. But as already mentioned in connection with Bogra, the fibre is sometimes dipped for a few minutes into a boiling solution of *haldi* (turmeric) from the idea that it is thereby softened and rendered more easily separable into the fine bands of fibres required by the fishermen. In one instance, I was in Bogra told that the partially cleaned fibre was boiled for a very short time in the water obtained after cooking rice This was also said to soften the fibre. It is probable that in both illustrations the advantage secured has been exclusively obtained through the act of boiling the fibre. At the same time it would seem desirable that the action of both rice water and turmeric should be chemically investigated.

Fibre Softened by being Boiled in Rice Water. *Conf. with para. 80*

Uses of the Fibre.

73 ***Industrial Uses***—With the single exception mentioned above in connection with Bhagalpur (*para* 54), I came across no person who was aware that the fibre could be spun into such fine yarn that it might be woven into fabrics In the case of Bhagalpur it is stated that it had been used some twenty years ago in admixture with silk Whether it is still so employed I have been unable to discover, but throughout Bengal and Assam it is spun into coarse thread three strands of which are again spun together to make fishing lines and the cord from which the *kai jalas* or fishing nets are made.

Markets where Fibre may be Purchased.

I heard of one or two markets or annual fairs at which the fibre, the cord, or the nets of rhea were regularly offered for sale, such as the *Bora Daroga mela* and the fair at Kaunia

74 ***Ribbons***—But there is one point I desire to pointedly draw attention to in this place. I never in all my wanderings came across an instance in Bengal where ribbons with their adhering bark were stripped off and either subsequently cleaned or dried and sold in that state It is customary to find in reports published in Europe the statement that ribbons are exported from India I cannot say definitely that that may not be so, but I should think it highly likely that the supply must be exclusively derived from European experimental plantations or prepared to order. The Bengal cultivator invariably scrapes off the bark before separating the fibre from the stem, and

Ribbons not Made in Bengal. *Conf. with paras. 13, 44, 80, 82.*

thus offers for sale what may be a crudely cleaned fibre (China-grass), but it is, certainly, not the much condemned "Indian rhea ribbons" that have given an evil name to, and greatly lowered the value of, the Indian fibre.

CONCLUSIONS.

75 *Machinery.*—
cates first, then strips
more rational one the
inventors of the so-called decorticating machines hitherto made known. These simply either strip off the bark with its adhering fibre or smash up the contained stem (scutching) and liberate the bark and fibre in that way Some of them by a subsequent action no doubt get rid very largely of the adhering bark, but they fall far short of the operation of complete removal of the bark, and green pulpy external tissue that is immediately effected by the cultivator on the stems being cut. Whether his subsequent process of drying the exposed fibre before separating it from the stem is advantageous or not I have not had the opportunity of testing, but long experience with the Indian cultivator has prejudiced me in favour of the view, that he rarely does much within his own sphere of life that is useless, and he certainly never imposes on himself very considerable additional labour to no purpose.

79, 86, 98.

Decorticating Machinery. *Conf. with paras.* 2, 43, 81, 87, 226-8.

Drying Fibre: *Conf. with paras.* 72, 79, 80, 86,

CULTIVATION IN ASSAM.

ASSAM.

76. ***History.***—It has been already stated that the earliest mention of this plant in connection with Assam occurs in a letter from Captain Jenkins, dated January 1833. Modern writers have distorted the reports and letters furnished by Jenkins, Dalton, Hannay, Masters, and other early Assam explorers, when they have affirmed that these writers have stated that **Bœhmeria nivea** (variety **tenacissima**) is indigenous to Assam. Subsequent to the date of the discovery of the cultivation of rhea in this province a wild plant, which yields a remarkably strong fibre and which is called *bon-rīha* (wild rhea) was found. Although none of the early investigators made the mistake of confusing these two plants, their less careful descendants and compilers have done so, until the statement of rhea being indigenous to Assam has become current in the literature of this subject. *The Dictionary of Economic Products* was by express instructions of the Government of India intended to be a compilation of all existing information regarding the Economic Products of this

Discovery by Jenkins. *Conf. with paras.* 19, 22.

Bon Rīha.

The Account of Rhea in Dictionary of Economic Products.

BENGAL CULTIVATION

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CONCLUSIONS.

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Decortication before Stripping. *Conf. with paras. 72, 79, 86, 98.*

75. ***Machinery.***—The Bengal cultivator, strictly speaking, decorticates first, then strips the fibre, and it seems to me his process is a more rational one than that followed by each and every one of the inventors of the so-called decorticating machines hitherto made known These simply either strip off the bark with its adhering fibre or smash up the contained stem (scutching) and liberate the bark and fibre in that way Some of them by a subsequent action no doubt get rid very largely of the adhering bark, but they fall far short of the operation of complete removal of the bark, and green pulpy external tissue that is immediately effected by the cultivator on the stems being cut Whether his subsequent process of drying the exposed fibre before separating it from the stem is advantageous or not I have not had the opportunity of testing, but long experience with the Indian cultivator has prejudiced me in favour of the view, that he rarely does much within his own sphere of life that is useless, and he certainly never imposes on himself very considerable additional labour to no purpose.

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Bon Rīha.

The Account of Rhea in Dictionary of Economic Products.

ASSAM.

country. Before the date of having prepared the account of rhea given in that work, I had not had an opportunity of botanising in either North Bengal or Assam. Moreover, I could not omit from the Dictionary opinions of distinguished investigators, simply because they might be opposed to my own views. The present report will be understood, therefore, as the outcome of personal investigations, and accordingly should be regarded as superseding my previous writings on this subject. I make this statement because I am fully aware of holding opinions now that in certain directions are opposed to the statements I previously advanced regarding rhea in Assam.

Existing Conditions not Investigated.

77. ***Definite Information.***—There would seem no doubt that, when the Government of India offered a reward of £5,000 for a rhea fibre-extracting machine to fulfil certain conditions, it would have been advantageous had the idea occurred at the time to those in authority, to have a survey made of the reputed areas of rhea production. Indian botanists had not specially investigated the forms being grown nor whether or not the plant was indigenous to India. Botanical writers in Europe could hardly, therefore, have been expected to pointedly correct the misconceptions that prevailed in India. But in the *Flora of British India* Sir J. D. Hooker gives the name of this plant in the type used for introduced plants, and he says of it, "Cultivated in the warmer parts of India, specially Assam and Bengal." It may, therefore, be now accepted that the old error of viewing it as indigenous to Assam has been authoritatively corrected. Jenkins, Masters, Griffith and other early botanists make no mention in any one of their numerous contributions to scientific journals, etc., of their having met with it in Assam in a wild state. There is not a suspicion even of any of the numerous specimens preserved in the Herbarium of the Royal Botanic Gardens, Calcutta, of having been collected from a wild source. All are definitely stated to have been culled from the cultivated plant.

Reward for Machines. *Conf. with paras. 226-228.*

Plant not Indigenous to India. *Conf. with paras. 6-7, 41, 42, 44, 52, 60, 76, 83.*

No Record of its being Wild.

Mishmis Supposed to be Earliest Cultivators of Rhea.

But speaking of the early history of this plant Dalton says of the Mishmis that—

"They were probably the first people on this side of the Himálaya to discover the valuable properties of the Rhea nivea (sic.), and many others of the nettle tribe; with the fibre of one of these nettles they weave a cloth so strong and stiff that, made into jackets it is used by themselves and by the Abors as a sort of armour."

HISTORY.

It seems probable that the jackets to which Dalton alludes were made, not of rhea, but of *ban-riha* (Villebrunea integrifolia). At all events that is the fibre which at the present day is woven into garments by most of the hill tribes of Assam. The Angami Nagas use largely the fibre from Girardinia heterophylla, but neither the aboriginal hill tribes nor the more civilized inhabitants of the plains weave the fibre of Bœhmeria nivea.

Ban Riha. *Conf with para. 191.*

Angami Nettle Cloth.

78. But to return to the more instructive historic facts regarding rhea in Assam, Captain Jenkins in a letter to Dr. Wallich, dated 25th July 1836, refers to the fact that the plant—

Wallich Identifies Assam Rhea.

"Does not bear to be flooded" but a little further on he adds, "It occupies high lands of little or no value It, however, occupies the land constantly; against this there is the set-off, that it requires little or no cultivation."

It is somewhat difficult to understand what Jenkins could have meant by rhea requiring little or no cultivation since his contemporaries all speak of it as necessitating a rich soil and constant attention. Masters in a memoir on the natural productions of the Angami Naga country (*Journ. Agri.-Horti. Soc. Ind., VI.* (*1848*), *p. 44*) refers to it as "The common Rhea of Assam, Urtica nivea, which is cultivated by the *Dooms* for net twine." Major S. F. Hannay in a paper on "The Rheas or Nettle Grasses" (*Jour. Agri.-Horti. Soc. Ind. Vol. VII.* (*1850*), *pp. 215-25*) gives much useful information on this subject. In fact the present brief historic sketch of the discovery of the crop in Assam and of the early knowledge regarding its cultivation, would be incomplete without full justice being done to Major (afterwards Colonel) Hannay, and since the report of his experiments may not be readily procurable by most persons it may be as well if I quote the greater part of it in this place.

Conditions of Soil. *Conf. with paras. 46, 49, 50, 62,*

79. ***Methods of Cultivation Recorded by Early Observers.***—Colonel Hannay tells us that—

Colonel Hannay's Practical Experience.

"The sole cultivators of this plant are the *Dooms* or fishermen, who use it chiefly in making their nets; they cultivate it in very small quantity, however, and as the fourth crop is that which bears seed, and they cut it down before the seed is formed, the plant is propagated entirely by dividing the roots. The ground is a small plot close to their huts which they have good opportunities of attending to, and manuring well with ashes and cowdung, a quantity of which is essential to the proper growth of the plant.

Seeding. *Conf. with paras. 17, 28, 31, 83.*

Well Manured. *Conf with paras. 91, 96.*

BŒHMERIA nivea. | Colonel Hannay's Report.

ASSAM.

Number of Cuttings. *Conf. with paras. 70, 71, 79-80, 81, 83, 84, 85, 86, 96, 99-100.*

"I have mentioned four crops, but as I have now a crop, the fifth, since planting, fit for cutting in February 1851; and I see others belonging to the *Dooms* in the same state, there will be five crops since planting, or six crops from April to April; the last or cold weather crops cut in February, being considered to produce the strongest fibre. However, as *moisture seems so essential to the quick growth of the plant, generally* speaking, after the early November, or fourth crop, the *Dooms* allow the cattle free egress into their plots and it is thus kept down until February, when some pains are taken in opening out the roots, heaping up the earth, and manuring them as well as enclosing afresh the plot of ground. The soil from repeated manuring is of course rich, and on this, and a good degree of shade and protection from storms, depends the luxuriance of the crop, which I have seen here eight feet high, and the extracted fibre six feet long. So much attention indeed is given to length of stock amongst the Kakoos of the Chinese Frontier, that the gardens are walled in (with wattling) like a *Pan* (Piper Betle) garden.

Manured in February.

Height of Crop. *Conf. with para. 100.*

Fenced in.

"From the roots thus dressed up in February a crop will be cut in April, another in June, another in August, and another early in November; the most luxuriant crop being those of June and August, as naturally receiving the greatest quantity of moisture. The fifth crop takes from early in November to February, to come to maturity. Between the cuttings all that seems necessary is a fresh opening up of the ground around the roots, which in a regular plantation is best done by hoeing between the rows with a spade-shaped *hoe* set in a long handle; the person, as he performs this, going backwards, so as not to step over his work; — in fact, nothing can be more simple than the cultivation of this plant: all that is required being a loose rich soil, and protection to the crop, by a good strong fence. The roots throw up at least 12 shoots when in full bearing; should they increase, and the crops get too thick, the roots require to be separated: and by this means of planting out fresh ground and new plants from seed, the cultivation can be carried to any extent. *It may be as well to mention also in comparison with the Chu Mah* * that the roots produce a crop of stalks the first year, and that a *poorah*, or one acre, would probably produce about 6 maunds of fibre in the twelve months.† But the next stage, that of cutting and removing the

Seasons of Cutting. *Conf. with paras. 70, 86, 96.*

Hoeing Necessary.

Number of Shoots to the Root. *Conf. with paras. 70, 86, 96.*

Yield of 12 maunds an Acre *Conf. with paras. 34, 71, 79-80, 81, 83, 84, 85, 87, 89, 96, 99-100.*

* I can only give my Chinese authority here for noticing that "*Chu Mah*" is the name of this hemp or flax at a particular stage, that is "uncleaned" flax or hemp, but of course I cannot vouch for the truth of this.

† Major Hannay mentions in a subsequent communication, that he has greatly under-rated the quantity of *Rheea* produced on an acre of land. *What it may be under every possible advantage of cultivation he* is at a loss to say, but he thinks it likely to be more than double the quantity stated above.—*Ed., Agri.-Hort. Soc.*

B. 576-606.

fibre from the stalks, is the most difficult and expensive, and is practised by the *Dooms* as follows:—

80. "***Cutting and Removing the Fibre from the Stalks.***— The stalks are considered fit for cutting when they have become of a brown colour, for about six inches above the roots. To cut them the *Doom* seizes the leaves at the upper end with his left hand, and passing the right hand down to the root, strips off the leaves and cuts the stalk close to the ground. The stalks are made up into bundles, and the scraping off the outer bark commences at the same time, or this operation is deferred until the whole crop of the plot has been cut. The scraping off of the fibre from each stalk is a very tedious operation, and is performed with a blunt-edged knife; all that is left is the fibre and the woody part of the stalk, which are exposed to a hot sun for two or three days to dry The third morning, after having been exposed to the dew for several hours, the fibre is drawn off. This is done by breaking the woody stalk right through, towards the thicker end, and then sepa [illegible]
small end,
so as to
end, what remains on the thick end of the stalk is pulled off in the same manner. It will be seen that this is a very clumsy way of extracting the fibre, and, as far as I can judge, ⅛th of the fibre still remains on the stalk, which may be taken off, however, at a second breaking; but the *Dooms* are not particular so long as they get what they require.

"The hanks of fibre are then separately twisted at the upper end, and tied up in bundles of long hanks of about one seer in weight, if to be kept for sale: as the fibre, however, thus extracted, is quite ready for the purpose of net making, little or nothing more is done, than to open out and prepare the threads for spinning, which is done first by drawing the single hanks several times with a blunt-edged slip of bamboo held in the right hand, this softens and strengthens the fibres, and they are more easily opened out to the required fineness with the fingers and thumb nails, and then made up into small hanks ready for the spinning process; the first stage of which is performed by the women, with the common *takro* or spindle, in general use throughout India, the hanks having been well opened out and spread over the top of a high circular open bamboo frame, set end-ways on the ground. The further operations of spinning these first threads to the requisite thickness and the weaving of the nets is performed by the men."

"The qualities of the *Rheea*, however, deserve much more attention than is given to it by the *Dooms*: a steeping of the fibre for the night in a decoction of the Arum plant, with a subsequent washing in clean river

REVIEW of EARLY OPINIONS

Yield of Fibre per Acre.
Conf. with paras. 71, 79-80, 81, 83, 84, 85, 96, 99-100.

Maturity of Stalks.

Leaves Stripped.

Bark Scraped off.

Ribbons not Formed.
Conf. with paras. 13, 43, 75, 82.

Conf. with paras. 72, 86, 100.

Fibre Removed from Stems.

After Treatment of Fibre.
Conf. with paras. 51, 54, 72.

Spinning.

Steeping in a Starchy Fluid.
Conf. with para. 73.

BŒHMERIA nivea. | Colonel Hannay's Description of Chinese Method.

ASSAM.

Polishing or Silvering the Fibre.

Use of Acid Water. Conf. with paras. 81, 98.

Dyeing the Fibre.

water, improves the colour and softens the fibre very much, added to which *a slight hatcheling on the blunt-edged bamboo, or drawing the* single hanks with a piece of coarse cloth held firmly in the right hand, brings it quite in a state of preparation for the English patent hackling machine. In the state of yarn it is easily affected also by the acidulated water of the fruit of the Garcinia pedunculata, and thus prepared for taking colour more readily, and when dyed black it has great glossiness and would, I think, answer well for all kinds of common braiding."

81. ***Dalton's Scheme of a Premium.***—In a letter addressed to Colonel F. Jenkins, Revenue Commissioner of Assam, Captain E. T. Dalton, then Collector of Lakhimpur, on the 1st March 1853, advised despatch of a consignment of fibre that had been prepared by Major Hannay from a field of:—

Yield per Acre. Conf. with paras. 34, 71, 79-80, 83, 84, 85, 87, 96, 99-100.

Price. Conf with paras. 3, 4, 9, 43, 65, 71, 81, 83, 84, 103, 126, 140.

Encouragement by Premiums on Production.

Cost of Production. Conf. with paras. 34, 71, 85, 87.

Cheaper Preparation. Conf. with paras 226-28.

Land Available in Assam.

"Rather more than three *bighas*, or just about an acre of this plot is planted with *rheea*, which last season gave seven Indian *muns* of fibre." Captain Dalton then says, "At present the cultivation is restricted to a particular class, the *Dooms* or fishermen, and the only use made of the fibre is *in the manufacture by them of nets. For this purpose the fibre* sells in the bazar at as much as eight annas the seer. The price is high only because the quantity raised and required has hitherto been so small." "To offer a premium would be better than to have an experimental Government farm, for there is no mystery in the process of rearing the plant, and the premium would stimulate the ryots equally with the speculator."

In reply to this letter Colonel Jenkins wrote that by—

"The method of preparation adopted by the Chinese and myself, costs at least R5 per maund, you will see that it can scarcely be sent to Calcutta at the price offered.* however, it is to be hoped that some cheaper method of preparation from the stalk may yet be adopted, in which case, considering the advantages of such quantities of available land in Upper Assam, I venture to say the Rhea would under-sell all other flax in the home market."

We are still on the outlook for a cheaper method of preparing the fibre than hand labour, but meantime tea has expanded to such an extent that it may be said that it is highly doubtful if suitable land is so very plentiful now-a-days as in Colonel Jenkins' time.

82. ***A Chinese Method of Cleaning Fibre in Assam.***—In a letter which appears in the proceedings of the Agri-Horti. Soc. of

* £20 a ton.—*G. Watt.*

India (*Vol. X*) for the 11th August 1858, Colonel S. F. Hannay returns to the subject and furnishes particulars of a new method of removing the fibres in the form of ribbons which he calls the Chinese method. As the passage is of historic interest it may be given here:—

REVIEW of EARLY OPINIONS.

Preparation of Ribbons.

Conf. with paras. 13, 43, 75, 80.

"The stalks of the *Rheea* are cut to within 3 inches of the ground and each being broken in the middle by a particular method, by passing the fingers towards each end and through the fibre, this is stripped off, the outer bark and all; the stalks are left on the ground, and the strips made up into bundles, are placed in water for about a couple of hours; this steeping extracts a quantity of brownish-coloured matter, which would discolour, if not injure, the fibre if allowed to remain.

Steeping in Water.

Conf. with paras. 39, 61, 72, 100, 162.

"The bundles are then tied at the small ends, and hooked on to a post; each strand is taken separately in the left hand, and with a blunt knife in the right hand they are cleverly deprived of their outer bark; one draw of the knife, along the inner side, taking away the pulpy matter which remains there, thus leaving a clean strand of fibre only, which, hung up inside to dry in wet weather, or exposed to a little sun and a night's dew in dry weather, is fit for the English market. In scraping off the bark, a small quantity of long and short fibre goes with it. When the work is finished, take up the whole of this entangled refuse, put it in clean water for a short time, dry and beat it out, and the result is the tow I now send; and thus every particle of the fibre on each stalk is saved. The tow subjected to bleaching would, I think, be found useful in many ways, for instance, to be made up into hospital lint, or for paper.

Scraping Bark from Ribbons.

Waste.

Conf. with para. 80.

Bleaching.

"The above method of preparing the *Rheea* is different from that pursued by the Assamese *Dooms*, and which I have already detailed in a former notice of the *Rheea* fibre But a cheaper method of preparation, and one which is best suited for preparation on the large scale, is to subject the strips of fibre, after being taken from the stalks, to the steaming process in boxes, tubes or cylinders The steaming will soon carry off the sap and its bad qualities, and the bundles well dried will then, I think, be quite in a marketable state"

Doom Method.

Steaming Process.

Conf. with paras. 54, 121.

83. *Other Opinions.*—Mr. G. Mann, then Assistant Conservator of Forests, wrote an interesting letter on the 4th July 1870, certain passages from which may be here usefully recorded:—

Mr. Mann's Report.

"I have not seen this plant growing wild in Assam, and the Natives state that it is not met with wild." "The cultivation of the plant is generally carried on on small patches of cleared, well prepared, and heavily manured land, near the huts of the *Dooms* or fishermen." It is propagated

Is not Wild.

Conf. with paras. 6-7, 41, 42, 44, 52, 60, 77.

BŒHMERIA nivea.

Rhea *versus* Tea.

ASSAM.

Heavy Manuring Essential.

Seeding Doubtful.

Conf. with paras. 17, 28, 31, 79, 128.

Yield.

Conf. with paras. 34, 71, 79-80, 81, 85, 87, 96, 99-100.

Shade Injurious.

Price.

Conf. with paras. 3, 4, 9, 81, 84.

Ban Rhea.

Cultivation Necessary.

Conf. with paras. 45, 46, 55, 62-65, 79.

Cultivation Pays.

Conf. with paar. 96

Native Production Doubtful.

by division of the root stocks and not by seed. The Natives state that it bears seed, which, I think, however, is doubtful." "The quantity and quality of the fibre increases and improves the more care is bestowed on the preparation of the ground." "If well cultivated, three to four crops may be obtained during the season; the plant will reach a height of four to five feet. If grown in the shade of a tree it produces less and of an inferior quality than in the open. If the ground on which the plant is grown gets inundated, the plants die." "The fibre is grown chiefly for home use, not for exportation. Sometimes, if sold amongst the fishermen it fetches from 12 annas to R2-8-0 per seer."

"The wild or '*Ban Rhea*' of Assam is a species of Urena, a common tropical weed of the order of Malvaceæ and not related to the true rhea." "For the above reasons I am of opinion that the rhea plant cannot be freely produced in Assam in a 'wild' or semi-wild state with scarcely any cultivation, since the vegetation of this Province is so luxuriant and dense that the rhea plant is not at all likely to become master over it. Any care bestowed on the cultivation of rhea does well repay itself, and the Province is exceedingly well suited to its cultivation; but like many other products, to make it remunerative, it requires industry and energy, both traits almost unknown to the present scanty population of Assam"

84. Some years later Mr. Mann wrote a report on the Cultivation of the Rhea Plant in Assam (see reprint in *Dictionary on Economic Products, Vol. VI, Part I., pp 464-65*). The following passages may be taken from that report so as to more fully exhibit Mr. Mann's views :—

Outturn per Acre.

Conf. with paras. 71, 79-80, 81, 83, 85, 96, 99-100

"The outturn per acre, according to the statements of the *Dooms*, or fishermen, in the different districts where I made inquiries, is only from 200 to 300lb of clean fibre an acre per annum; but their statements are very unreliable."

Price.

Conf. with paras 3, 4, 9, 34, 68, 71, 103, 126, 136, 140.

Cost of Production.

Conf. with paras. 34, 71, 81, 87.

"The main question at issue is, whether the Rhea plant can be cultivated sufficiently cheaply in this province so as to allow the fibre to be used to a greater extent in the manufacture of cheap articles, produced in large quantity, so that it may become a great staple and develop into a large trade, as is pointed out by Dr. Watson, in paragraph 45 of his report. If its extensive introduction into the home markets depends on its being supplied at an average price of £30 to £40 per ton of rough fibre, as stated by Dr. Watson, in paragraph 46 of his report, this province will not be a source of supply, since it cannot be produced here at even double that rate at present, or in future either as far as can be judged now, for its production requires as much time and labour as tea does,

B. 576-606.

whilst the latter plant produces on an average 280lb per acre, and fetches on an average one shilling and eight pence per pound in Calcutta.*

REVIEW of EARLY OPINIONS.

"In fact, at the above low value of Rhea fibre, as quoted by Dr. Watson, it would only give a return about equal to rice, whilst its cultivation *requires double and treble the time and attention.* For this reason, I do not even see a likelihood of its being grown in the Sylhet district, where there is a greater population, and labour is comparatively cheap."

Twice or Three Times as Trouble-some as Rice.

"From the above remarks it will be seen that Rhea fibre has no chance in this province since the success of the tea cultivation will, as far as can be judged at present, always prevent European capital being employed on Rhea cultivation, and it is far too laborious for natives of this province to take to, as they have done in Bengal to jute cultivation, for the sake of gain, as long as the fibre has to be produced at £40 per ton."

Rhea Fibre has no Chance in Assam. *Conf. with para 93.*

Tea will always be Preferred. *Conf. with paras. 101, 186.*

85. While Rhea cultivation is referred to in many official publications, subsequent to the above Selections from the Records of the Government of India, *very little information of a definite nature* has been brought to light regarding the yield of fibre per acre. The following passage from the Agricultural Report of Assam for the year 1885-86 will, however, be read with interest. It confirms in general terms the reports published by the jails regarding their experiments in Rhea cultivation.

Yield per Acre.

The following passage from the Report of the Agricultural Department of Assam for 1885-86 is here given as it records the results obtained during an experimental cultivation at Nowgong :—

"A small quantity of Rhea was grown in the Nowgong Jail during the year under report. *The object of the experiment was double.* Details as to the cost of producing the fibre were required, and a comparison between the crop as grown in shade and as grown in the sun, was wanted. The second object was quickly gained. The plants put down in the shade refused to grow at all and were a total failure. The patch grown in the sun, on the other hand, did well. An area 71'×74' (=1 k. 3 l.) was planted in the jail garden in the middle of April."

Nowgong Experiment. *Conf. with paras. 99 and 100.*

Plants Grown under Shade were a Failure.

"The first cutting yielded 3 seers of dried fibre in July. The second cutting yielded 10 seers 9 chittacks in September. The third cutting yielded 7 seers 4 chittacks in October. Total yield in six months = 20 seers 13 chittacks=value (at R1 per seer) R20-13.

First Cutting.

"The total cost of planting, cutting, and extracting the fibre was R13; consequently, on an expenditure of R13 there was in six months a profit

* This unfortunately could hardly be given as the average price obtained for tea at the present day.—*G. Watt.*

BŒHMERIA nivea. — Mr. Bruce's Report.

ASSAM.

Five Cuttings. *Conf. with paras. 70, 79, 86, 96.*

Profit.

of R7-13. When I saw the crop in the middle of December it was nearly fit to cut, and might safely have been estimated to yield one more crop before the following April. Therefore, five crops might be calculated on from the above data in one period of twelve months. But the produce from three crops was 20 seers 13 chittacks; therefore the produce from five crops would be 34 seers 11 chittacks. (I have allowed for slower *growth in the cold weather by only taking one crop between December and* April) But the cost of cutting and extracting fibre from one crop was R2. Therefore, the cost of the two additional crops would be R4. Therefore the total expenditure in twelve months would be R17. Therefore the net profit in twelve months would be R17-11, or, roughly, 100 per cent. per annum. Working out the figures for the acre we see that the weight of fibre obtainable would be 911℔ and the cost R222 per annum."

Mr. Bruce's Opinions and Experience.

86. Mr. H. W. Bruce, a practical tea planter, wrote to the Deputy Commissioner of Darrang a letter (2nd July 1870) much to the same effect as Mr. Mann's first letter. The following passages may be taken from Mr. Bruce's communication :—

Must be well Manured. *Conf. with paras. 79, 91, 96.*

Method of Planting.

"Whatever be the quality of the soil, it has to be well manured with cowdung. After the ground has been cleared, it should be well deep-hoed. A quantity of manure should then be scattered all over the land *after which it should be well ploughed over several times, so as to thoroughly* mix the manure with the soil. It must be prepared in January or February, not later." "Immediately the ground is ready, rhea roots must be procured and planted in the drains about nine inches to a foot apart. The roots should be completely covered with earth. In April the rhea will have grown to about two to three feet in height, and is then ready to be cut; but as it generally throws out branches and grows crooked in its first growth, it is cut close to the ground, and all the cut stalks, branches, leaves, etc, are allowed to lie and rot in the ground to enrich the soil. In the course of a month about eight or ten straight stalks grow up from each root to the height of about four feet, and are ready for the second cutting They are cut down close to the ground, and grow up again in the course of another month to be cut a third time."

Green Manuring. *Conf with paras 70, 100.*

Cuttings and Yield. *Conf. with paras. 71, 96, 99-100.*

More Manure.

"In the first year of sowing, after the fourth cutting, it does not grow long enough to be of any use. In November more manure is put to the roots and after each cutting the ground is weeded."

Six Cuttings

Transplanted in Fourth Year.

"In the second and third years the rhea is cut six times, that is, if the soil is good and well manured, not otherwise. After the fourth year, as the growth becomes less vigorous, the roots should be taken up and sown elsewhere."

REVIEW of EARLY OPINIONS.

"After the rhea is cut, the outer bark or skin should be scraped off. This should be done on the day the rhea is cut, if possible, but not later than the *second day, as the bark dries, and is not so easily taken off as* on the first day when it is quite in a green state. The Assamese take the bark off with a flat piece of bamboo, about six inches in length and an inch broad, with rather sharp edges. One man can generally scrape about 300 stalks in the course of the day. After the outer bark is taken off, the stalks are put in the sun to dry. When thoroughly dried, the fibre is peeled off.

Scraping the Stems. *Conf. with paras. 72, 79.* The Scraper. A Day's Work Stalks are Dried. *Conf with paras. 72, 80.*

"The fibre after being well washed and combed is dried, and is then ready for use. By some it is combed so fine that it has the appearance of silk."

87. ***The Cost of Cultivation.***—"In my opinion I do not think that any profit can be made on rhea cultivation until a machine is made that will take off the outer bark and extract the fibre. The expense in cultivation alone is small in comparison with the cost of taking off the bark and fibre.

Cost of Cultivation Small. *Conf. with paras 34, 71, 81, 84, 85.*

"From my experience in cultivating a small piece of 2½ *cottahs*, I think the expense on one *poorah* would be as follows:—

No Profit can be got without Machinery. Cost of Production. *Conf. with paras 3, 9, 34, 43, 65, 71, 85, 103, 140, 159.*

	R
Price of labour, R5 and R4 per mensem; clearing, hoeing, ploughing, manuring, and sowing, for the first year .	50
Weeding throughout the rains, and manuring again in November or December	25
Cutting rhea, taking off bark, and extracting, the fibre, four times for the first year	200
Cost of weeding and manuring for the second year . .	25
Cutting, taking off bark, and extracting fibre, six times for the second year	230
Same expense for the third year	255
Same expense for the fourth year	255
Total expense for four years	R1,040

"The probable yield from one *poorah* would be about ten maunds which amount, even if it realized R500 (at R50 per maund), would shew a loss of about R500 at the end of four years."

Probable Yield. *Conf with paras. 79-80, 81, 83, 84, 89, 96, 99-100.*

"For the first year the yield is about four seers per *cottah*, or two maunds from *poorah*. This is what I have found it to be from my own experience; but as I only tried it for one year, I cannot say what the out-turn would be on better soil.

Possible Loss.

"From what I have been informed by the Natives who nearly all cultivate small patches of rhea for their own use, the yield in the second year is about one-half more than in the first year; and in the third and fourth years it is about the same as in the second year."

ASSAM.

Two Visits to Assam.

PERSONAL EXPLORATIONS IN ASSAM.

88. I visited Assam on two occasions; *first*, from March to July 1895, in connection with investigations into the Pests and Blights of the Tea Plant, and *second*, during February and March 1897, in connection with the present enquiry. On both occasions I devoted considerable attention to the study of Rhea, and made numerous collections of specimens in every district except Goalpara which I was unable to visit. On my arrival at Gauhati on the 26th February 1897, I had the pleasure to meet Mr. Monahan, Director of Land Records and Agriculture, and we consulted together on the subject of Rhea. At his request I showed him most of the collections I had made up to date, explained fully the confusion that had arisen both as to the Assam plant having been wrongly supposed to be the variety **tenacissima** and as to its being by some writers spoken of as indigenous to the valley. Mr. Monahan was good enough to agree to co-operate with me and undertook to supervise the work of one of my plant collectors, during a tour of inspection through the district of Kamrup. Mr. Monahan has, however, anticipated this report somewhat by publishing the results of his enquiries in Bulletin No. 5 of the Agricultural Department of Assam. In consequence that paper may be said to be the first Indian publication that has definitely corrected the errors I have above indicated. But since the views set ... nearly coincide with my own, I do not ... the villages visited by me, nor to ... methods of culturation ... therefore, take the ... Monahan's *Note*, but ... and details ... ment of the ... desirable I ... of Mr. Monahan ... later parti... combined report ... Monahan may discover no ... of his useful report:—

"... (*Riha*) is the vernacular name ... in the four upper districts of the ... Darrang, and Nowgong In some parts

Goalpara. *Conf. with paras. 22, 24, 30, 33.*

Imperfect Knowledge Regarding the Assam Rhea.

Conf. with para 12.

The Assam Bulletin of Agriculture No. 5, Rhea.

[Overlapping damaged text:] ... grown to about ... ready to be cut; but as it generally ... crooked in its first growth, it is cut close to the ... lie and well, ... about eight ... ght of about four feet ... down close to the ... her month to be cut ... rth cutting, it does no ... more manure is ... ed." ... cut ... Where it may ... some of the sections ... though ... of certain additional ...

Manuring. *Conf. with paras. 70, 100.*

Cuttings and Yield.

of the Kamrup district it is known as rhea, and, in others, by the Bengali name, *Kankhura.*" Mr. Monahan then adds, "In the Surma Valley (Sylhet and Cachar districts), no form of rhea is known to the native cultivators."

RECENT OPINIONS.

It will be seen that, according to a letter in the Journal, Agri-Horticultural Society, Captain Jenkins first made acquaintance with it in Cachar.

Jenkins Discovered it in Cachar. *Conf. with para. 22.*

90. ***Area under Rhea.***—"There are no accurate statistics of the area under rhea in Assam. The crop is found, here and there, throughout the five districts of Kamrup, Nowgong, Darrang, Sibsagar, and Lakhimpur, and is raised by cultivators of all classes; not by the fishing caste only, as has been stated In spite of this wide distribution, the total area under rhea is unimportant In the districts named, its cultivation is confined to a small proportion of the total number of villages, and in any one village, as a rule, not more than half a dozen *raiyats* will be found who cultivate it, while the average area cultivated by each *raiyat* is, as already stated, extremely small.

Fishermen Cultivators *Conf. with paras 47, 79, 89, 90.*

"In the whole of the Assam Valley, the total area under rhea probably does not exceed 2,000 acres. The small extent of rhea cultivation in Assam is easily understood, when the labour involved in preparing the fibre is taken into account, and when it is considered that the Assamese manufacture from it fishing nets and lines only, and are unacquainted with the higher uses to which it can be put."

Area under Rhea.

91. ***Soil and Manure***—"The soil on which rhea (Bœhmeria nivea) is cultivated should be light and free, not stiff, and either naturally rich, or well manured. It must also be above the reach of inundation, and well drained, as the plant is at once killed by water lodging at its roots. Subject to these conditions, it would appear that rhea can be grown in Assam on a variety of different soils. In the Assam Valley, the rich loam which composes good tea land has been found suitable for it, and in Sylhet it is reported to be grown most successfully on well-drained *bhil* land. By the Assamese, however, it is most usually raised on sandy loam, which has been artificially fertilised, chiefly with cow-dung manure."

Suitable Soil. *Conf. with paras. 46, 49, 60, 62, 78.*

Sandy Loam.

Mr. Monahan adds a further circumstance of interest.—"The more careful cultivators, if the ground is not already well drained, and quite secure from inundation, commence operations by digging a trench about two feet deep round the patch selected. The ground must be well hoed."

Method of Cultivation. *Conf. with paras. 33, 69, 79.*

In several villages I was told that in addition to cowdung they also manured with dry grass and rice husk, mixed with earth obtained

Manure. *Conf. with paras. 79, 86, 96.*

months of April and May, and the first half of June, is characterised by intense, dry heat. In Assam there are no dry, hot months, the rains setting in regularly by the middle of April, and even during the cold weather *humidity is greater than in other parts of Northern India*. Accordingly, in Assam, rhea continues growing throughout the year, though at a somewhat slower rate in the cold weather than in the rains; and whereas, at Saharanpur, the crop is cut only twice a year, once in June, and once in October or November, in Assam cuttings are obtained at much more frequent intervals, as will be shown further on. According to the statements of numerous cultivators who have been examined, there is no difference, as regards the quality or their fibre, or the difficulty of separating it, between rhea stems cut in the cold weather and those obtained in the rains. The writer has seen, in March, at the end of an unusually dry cold weather, in Lower Assam, stems over six feet high, and apparently uniform of rhea plants which, he was assured, had been cut only two months before. The rapidity of growth, however, especially during the cold weather, depends much on the amount of manure applied, and the general care taken in the cultivation. The stems just referred to were grown on carefully tended land, while, at the same time, and on land of probably the same natural fertility, the rhea crop observed was withered and stunted and not likely to yield any fibre till the beginning of the rains."

RECENT OPINIONS.

No Dry Hot Months.

Growth during Cold Weather.

94. I venture to think that this circumstance is one of vital importance in rhea cultivation. In fact I have little doubt that in the future any expansion of production westward, within the sub-montane tract already indicated (*para. 66*) will bear a direct relation to the extent of cold season humidity.

Expansion of Area of Production.

Conf. with paras. 17, 30, 66, 90, 91.

95. ***Period of Duration on Fields.***—"Proverbially careless and unthrifty, the Assamese *raiyat* is little disposed to take trouble with a crop like rhea, the produce of which is required by him only in small quantities for domestic consumption. It is hence somewhat difficult to estimate from Assam experience what the crop is capable of under careful cultivation. In the majority of instances, except a little weeding during the first few months of growth, nothing is done for the rhea patch after planting, and its owner looks only to cutting the stems as often as they become fit for use. Under this treatment, after two years, the soil becomes exhausted, and the rhea stems grow weak and thin; the roots are then taken up, divided, and replanted elsewhere. The more intelligent *raiyats*, however, admit that, with frequent manuring, rhea can be continuously grown on the same land for many years; indeed they place no limit on the length of time for which the crop can be cultivated on the same land if only manure enough be applied. There is room for doubt as to what the

Transplanting.

Soil Exhaustion.

Conf with paras. 23, 141.

BŒHMERIA nivea. | Mr. Monahan's Note.

ASSAM.

Number of years Cultivated. *Conf. with para 96.*

maximum period is. In reports from China and America, very long periods, varying from 30 to 100 years, have been mentioned; but it seems probable that unless some process of thinning were resorted to, transplanting at comparatively short intervals would be necessitated by the overcrowding of the roots. In paragraph 8 of Mr. Montgomery's report on the experimental cultivation of rhea in Kangra (Dictionary of Economic Products, Volume VI., Part I., page 472) the removal of the roots every four years is recommended, in order to avoid overcrowding. On the other hand, in the report of the Superintendent of the Botanical Gardens, Saharanpur, quoted at pages 476-481 of the same volume, close planting is advocated, with a view to preventing the growth of weeds and improving the quality of the fibre. By the Assamese the crowding of the roots, as well as the impoverishment of the soil, is sometimes alleged as a reason for replanting the crop on fresh land, but the writer has seen rhea flourishing on land where it is said to have been grown continuously for eight years without thinning."

Close Planting Advocated.

Cultivated on High Beds of Manure.

The majority of the cultivators questioned by me in Assam affirmed that there was not much occasion to transplant the roots; they might be grown at all events on the same field for 20 years. But I would add that most of the old plots were some 12 to 18 inches in height above the level of the rest of the homestead enclosures, and I was told this was due to the annual addition of a thick coating of cowdung. And that statement seemed fully substantiated by the appearance of the plot of land which looked more like a cucumber bed than a field.

96. *Cuttings.*—On this subject Mr. Monahan writes:—

"In different published descriptions of rhea cultivation, in which the number of cuttings that can be obtained in a year is referred to, it appears to be implied that, at certain intervals, the whole of the stems from roots planted at the same time in a field can be cut simultaneously. This, however, is not the usual practice in Assam, where the received opinion is that, in order to obtain the greatest outturn and best quality of fibre, each stem must be cut at a certain stage of its growth, namely, when the lower portion of the stem turns brown, and before the plant has flowered. As all the stems from roots planted together do not reach this stage simultaneously, the custom is to cut selected stems from time to time as they become fit for use. In this way selected stems are cut at intervals of from one to two months in the rainy season, and from two to three months in the cold weather. Rhea planted at the end of the rainy season (October to November) will yield the first cutting about the end of March or begin-

Seasons *Conf. with paras. 86, 97.*

ning of April, if planting be carried out at the beginning of April, the first cutting may be obtained about the middle of May. When the crop has fairly established itself, cuttings may be taken regularly at the intervals mentioned above."

RECENT OPINIONS.

Number of Cuttings. Conf. with paras 70, 71, 79-80, 81, 83, 84, 85, 99, 100.

Most of my informants spoke of four or five cuttings a year, as, for example, in May, June, July, August and November or even December, depending on the nature of the season. But one old and experienced cultivator at a village in Sibsagar district, with whom Mr. Severin, of Sanari, and myself had a conversation, told us that he could make his field yield a cutting every 15 to 20 days. His contention was that yield was entirely a question of manure and moisture, and I presume he was not far from correct. He argued that the quality of the fibre depended upon the rapidity of growth, the older the stems the coarser the fibre, and hence in his opinion it was not only true that high manuring paid, but when moisture was deficient it would also pay to irrigate. A sudden interruption to growth of shoots he held ruined the fibre.

Quality of Fibre.

97. ***Irrigation and Weeding.***—But on the question of irrigation Mr Monahan writes:—"No irrigation is required for rhea in Assam. Between the time of planting and the first cutting, constant and careful weeding is necessary, but, after that, light hoeing between the rows after each cutting, and manuring once a year, if the soil be poor, seems to be all the cultivation that the crop requires."

Weeding. Conf. with para. 69.

98. ***Preparation of Fibre.***—Mr. Monahan says:—"The method of preparing the fibre in Assam has been described in reports previously published, and may be briefly recapitulated here. After the stems have been cut, the leaves are stripped off, and the green outer cuticle removed by scraping with a knife The stems are then dried in the sun for from four to six days, after which the bark is peeled off, and left to steep for two or three hours in cold water, in which pieces of some acid fruit are sometimes placed along with it. The acid appears to have the effect of dissolving the gum contained in the bark, and facilitating its removal After this steeping, the fibre is separated by washing the bark in clean water and rubbing it between the hands."

Preparation of Fibre. Conf. with paras 51, 54, 72, 80, 82.

Use of Acid. Conf. with paras. 80, 81, 100.

Every one of the cultivators questioned by me said it was most important that scraping off the green pulpy bark should be done at once If delayed, the fibre, they said, would become hard and much more difficult to clean. I presume that by the expression "after which the bark is peeled off" in Mr. Monahan's paragraph just quoted, he means the layer of fibres left adhering to the stem. Practically the

Scraping the Shoots. Conf. with paras 72, 79, 86.

BŒHMERIA nivea. — Mr. Monahan's Note.

ASSAM. The Gum.

whole of the bark is scraped off in the green state and with it by far the major portion of the gum. The fibre on being dried still no doubt contains a considerable amount of gum and the steeping in acid fluids, it may be recollected, is part of the treatment recommended by most of the patent processes for cleaning. Colonel Hannay has alluded to the use of **Garcinia pedunculata** which, if not exactly containing acid (in the chemical sense spoken of in the patent processes for cleaning) is at least highly astringent. It seems desirable that the exact action of these natural or rather vegetable acids should be chemically investigated. It is quite likely that some of them would serve the purpose of softening and removing the gum without entailing the risk of injury to the fibre.

Garcinia Fruits. *Conf. with paras. 80, 100.*

Yield per Acre. *Conf. with paras. 71, 79-80, 81, 83, 84, 85, 96, 100, 111, 117, 121, 123, 127, 131, 135-6, 155, 158, 171, 176-80.*

Kangra Returns. *Conf. with para. 158.*

99 ***Outturn.***—On this subject Mr. Monahan writes:—"It is necessarily very difficult to estimate, from the statements of Native cultivators, the average outturn of cleaned fibre which may be obtained from a given area of land under rhea, which is properly cultivated. As mentioned above, careful cultivation of this crop is the exception, and the *raiyat* who raises it, as a rule, on a diminutive patch, not exceeding three or four perches in extent, keeps no strict account of the fibre which it affords, a few handfuls at a time, for domestic uses. The Assamese peasant is, moreover, strongly averse to giving any information about the outturn of his crops, and any statements he makes on the subject are usually under-estimates. Calculations based on such statements, which may be taken for what they are worth, give estimates of outturn for rhea varying from 76lb to 605lb of cleaned fibre per acre. On the other hand, the estimate deduced from an experiment made in the Nowgong district jail * in 1885 was 911lb per acre. Mr. Buckingham estimates the outturn under favourable circumstances, at 640lb per acre, and this may probably be taken as a safe estimate for Assam. Mr. Montgomery after twelve years' experience of rhea cultivation in Kangra, estimated the outturn of cleaned and dried fibre at 972lb per acre."

Mr. Kershaw's Estimate. *Conf. with para. 100.*

The average of all the statements of yield made to me by the Assam cultivators approximates very closely to 8 maunds (640lb) of clean fibre to the acre. One very intelligent cultivator assured me, however, that a plot of land which I measured (15 yards by 30 yards) had for many years past yielded him one maund of clean fibre a year, which he was able to dispose of at R2-8-0 a seer, that is to say, it produced 10·75 maunds, or a return of R1,000 an acre.

* See para. 85, also Mr. Kershaw's remarks, para. 100.

RECENT OPINIONS.

This is very nearly the figure quoted by Mr. Montgomery (*para. 157*) and is less than that given by Colonel Hannay (para. 79).

Actual Crop Experiment.

100. But in this place it will be instructive if I furnish a report of an actual crop experiment made by Mr. L. J. Kershaw, Assistant Deputy Commissioner, Golaghat—

"Crop experiment Rhea (Bœhmeria nivea).

"First cutting (May 7th, 1897).

"The only record I can find of a rhea crop experiment made in Assam is of one conducted in the Nowgong jail in 1885. The cropped area was in that case almost exactly $\frac{1}{8}$th acre and the outturn reduced to ℔ per acre was—

Nowgong Experiment.

Cuttings.

		℔
First cutting,	July	48
Second „	September	169
Third „	October	116
	TOTAL	333℔ per acre.

"The present experiment refers to the first and least productive cutting of the season.

Highly Manured.

"The area of the plot selected was 430 square feet or as nearly as possible ·01 of an acre. This is the ordinary size of a plot of rhea grown by the *raiyats* in this district. The plant was cultivated on a cushion of rich sandy soil, liberally treated with cowdung *phutsai* (wood ash), charcoal and rubbish. The mature plants averaged 3′ 6″ in height. The stalks were first cut at about 2″ from the ground. The leaves were then stripped. These leaves were afterwards used as manure. The outer bark was then scraped off with a sharpened bamboo, the stems lightly rubbed with a cloth and carefully put aside. If the stems at this stage get wet or dirty the fibre is said to rot. This operation occupied 12 persons from 2 to $2\frac{1}{2}$ hours. The stems were then taken to my bungalow and placed in the sun each day until thoroughly dried and bleached almost white. This occupied four days. The fibre was then stripped from the stems. This occupied four men a day. As the method of extracting the fibre from the dried stems appears to be in some respects different from that described in the Director of Land Records' Note on Rhea (Assam Agri. Bulletin No. 3) I describe the process in some detail. The stem (but not the fibre) is first broken a few inches from the top. The operator holding in each hand the wood near the break, with a sharp motion something between a thrust and a twist, disengages the fibre from about an inch of the wood, which breaks into small pieces and falls. The fibre is then disengaged from the shorter piece of wood which is thrown away. The ends of the fibre are then carefully gathered together, care being taken that no strands escape. Holding the ends of the

Succulent Bark Scraped off.

Exposed Fibre Rubbed with a Cloth.

Fibre Dried. Conf. with paras. 72, 79, 80, 86.

Operation of Separating Fibre.

BŒHMERIA nivea. Yield of Stems.

ASSAM.

fibre in one hand and the stick in the other, a strong pull is given and a long tress of clean fibre is extracted. This operation is repeated low down the stem so as to take up any strands which may have escaped the first pull. The uncleaned fibre is then steeped in water, no acid fruit is put in the water by *raiyats* in this neighbourhood. The bundles of fibre are while still wet beaten violently against a flat board after the manner of a *dhobi* beating clothes. The fibre is then dried in the sun.

Fibre Steeped in Water. *Conf. with paras. 39, 54, 72, 82.*

"The cleaned fibre is spun into rhea thread with a small *takuri*, and twisted into rhea cord with a large *takuri*.

"During the cutting a sample batch of plants, weighing $2\frac{1}{2}$ seers, was divided into stalks of different length and scraped with the following results :—

Weight of Leaves.

Total weight	Length of stem.	No.	Weight after stripping leaves.	Weight after scraping bark.
			Tolas.	*Tolas.*
	3′	13	32	28
	2½′	25	31	23
Tolas.	2′	26	18	13
200	12′	19	6	3½
			87	67½
	Weight of leaves		113	bark 19½
	TOTALS .		200	87

"From the whole plot 1,396 stalks were cut. These were divided into lengths, weighed when wet, after the bark was scraped off, and weighed when dried. The results obtained were—

Weight of Fibre and Stems. *Conf. with para. 155.*

No. of stalks.	Average length.	Weight *tolas* (when wet after being scraped).	Weight after being dried in the sun 4 days.	Uncleaned fibre.	Cleaned fibre.
		Tolas	*Tolas.*	*Tolas.*	
347	3′ 2″	700	170	26	...
388	2′ 6″	430	80	16	..
431	2′ 0″	280	...	...	47½
230	1′ 3″	100	60	13	...
		1,510	310	55	47½
		Moisture	1,200	wood 255	7½
		TOTALS	1,510	310	55

RECENT OPINIONS.

"Combining these two results and reducing the figures to lb per acre, it appears that the total weight of the crop of an acre (stalks and leaves) would be 11,185lb made up as follows :—

First Cutting: Yield per Acre.

Conf. with paras. 51, 71, 79-80, 83, 84, 87, 89, 90.

	lb
Leaves	6,320
Bark	1,090
Moisture	3,000
Cleaned fibre	$118\frac{1}{4}$
Dirt and bark lost in washing the uncleaned fibre	$18\frac{3}{4}$
Sticks	637
TOTAL .	11,185

"The net result of the experiment is that the first cutting gives $118\frac{1}{4}$lb per acre or about $2\frac{1}{2}$ times as much as obtained in the Nowgong experiment.

"The following table shows the amount of uncleaned fibre extracted from :—

Percentages of Fibre.

		Percentage of fibre to wet stems.	Percentage of uncleaned fibre to dried stems.	Percentage of clean fibre to wet stems.	Percentage of clean fibre to dried stems.
Stem averaging .	3′ 2″	3·7	15·3		
	2′ 6″	3·7	20 0		
Short stem .	1′ 2″	3 7	21·6		
TOTAL .	...	3·6	17 7	3·1	15·3

"The plot on which the experiment was made was not regarded as good. I could indeed class it as under the average The shoots averaged only 3 to 4 feet in height, but possibly this is an advantage as it would appear that the shorter the stalk the greater the percentage of fibre extracted.

Height of Crop.

Conf. with paras 70, 79, 83, 86, 93, 100, 101, 113, 133, 168.

"I hope to be able to ascertain the yield of the 2nd and 3rd cuttings of the same plot. If the yield continues to be three times as great as that obtained in the Nowgong experiment, the total yield would appear to be over 900lb per acre. Any estimate, however, is useless until experiments of the yield of the 2nd and 3rd cuttings are made.

Total Yield 900lb.

BŒHMERIA nivea. — Prospects of Rhea in Assam.

BURMA.

"The owner of the plot experimented on gave me last year's yield. These figures must naturally be accepted with some caution. Reduced to ℔ per acre they are—

	℔
1st cutting	150
2nd "	225
3rd "	225
TOTAL .	600

101. ***Prospects of Rhea in Assam.***—The concluding pages of Mr. Monahan's *Note* are devoted to this subject, but as most of the points have been already abundantly discussed in the foregoing pages, I do not consider it necessary to furnish the entire passage. Speaking of the information derived from Native cultivators, he says:—

Garden Cultivation. *Conf. with paras 7, 35, 39, 47, 49, 55, 101.*

"It is certain that, on this point, no conclusion can be safely drawn from existing cultivation in the province, which is everywhere of the nature of garden cultivation." He then goes on to say the climate, as already shown, is exceptionally favourable "while waste land suitable for the crop is available in abundance."

Jute. *Conf. with paras 5, 39, 40, 84, 120.*

European Capital. *Conf. with para. 125.*

"On the other hand, there is no probability that the cultivation of rhea will ever be undertaken on a large scale by the Assamese *raiyat*, owing to the labour involved in the separation of the fibre by hand, and to the fact that any machinery or process by which it could be more easily extracted would be beyond the *raiyat's* means. The present condition of the Assamese peasant is such that he is not compelled to engage in any laborious occupation in order to obtain a subsistence, which is all that he requires, and even the trouble of preparing jute for the market has been sufficient hitherto to deter him from the cultivation of that crop, in spite of the large profits which it would probably yield him So far as present indications go, it appears that, if rhea cultivation is ever to become an important industry in Assam, it must be established there, like the tea industry, by European capital, with the help of imported labour. Before investing capital in this speculation, it would be well if parallel experiments could be made with Bœhmeria nivea and Bœhmeria tenacissima, in order to decide which variety thrives best in the Assam climate.

BURMA.

CULTIVATION IN BURMA.

102. ***History.***—I have already mentioned that the discoverer of Rhea in Burma was Colonel Burney. In a letter to Mr. J. Kyd, dated 6th December 1835, he gives us many interesting particulars which subsequent investigators have practically only confirmed. I make no hesitation, therefore, in republishing Colonel Burney's letter

so as to make this report on the rhea-growing districts of India as complete as possible. I have not had the pleasure of visiting the Shan States, and therefore have no additional particulars to offer except that, through the kindness of the Inspector General of Forests, I have been furnished with an admirable series of specimens. The plant proves to be **Bœhmeria nivea,** and not the variety **tenacissima.** Colonel Burney writes:—

HISTORY: Discovered in 1835.

"I send you a small specimen of a kind of *Hemp* which is brought here from the Shan Provinces of Pivela and Youkzouk, lying six or eight days' journey to the south-east of Ava. This material appears to others as well as to myself of superior quality, and I should like to hear your opinion of it. My inquiries from the Shans inform me, that they regularly cultivate the plant which produces this hemp; that it has a bulb-bearing root from which they propagate it; that the stem grows 5 to 6 feet high, and about the thickness of a man's fore-finger; that they cut it down to the ground once a year, and it grows up again from the same root as often as they cut it; and that this hemp forms a kind of rind or coat over the stem, and may be taken off after macerating the stem in water, or not—the former process, however, making the hemp much whiter in colour, although depriving it of some of its strength and toughness, after rubbing or scraping off the cuticle of the bark, the stem is beat all round, and this hemp peeled off. The Shans use this material in manufacturing every kind of cordage, and weaving a stout kind of cloth, of which they make bags. They call it *Pan*, and the Burmese, who know it only as coming, like almost every other good thing in this country, from the Shan Provinces, call it *Goun*. I have engaged some Shans to go to Pivela and bring me some of the stems, and a supply of bulbs and, if you think the material as good as I do and worth your attention, I will send you some of the bulbs and some to our Tennasserim Provinces, where, I think, the plant could be easily very extensively cultivated. The Shans put the bulbs into the ground in the beginning of the rains in March or April, and declare that the stems are long enough to be cut in September or October. The specimen I send you was gathered, some say, too soon, before the stem had attained its full growth. The Burmese have the common hemp plant, and call it *paik-lo han*."

Burney's Account of Discovery.

Met with in the Shan Country.

Steeping in Water. *Conf. with paras. 39, 54, 72, 82, 100.*

Bark Scraped off.

Woven into Cloth. *Conf. with paras 14, 54, 77, 204.*

Planted out at the Beginning of the Rains. *Conf with paras 69, 86, 92, 96.*

103. ***Experimental Cultivation.***—Two years later (1837) Captain H. Macfarquhar sent a sample of the fibre grown in his garden at Tavoy from plants furnished by Colonel Burney. Still later (1843)

Cultivated at Tavoy.

The "Urtica tenacissima"—for a description of which *vide* Dr. Roxburgh's Observations on Substitutes for Hemp and Flax, page 69.—*Ed., Agri-Hort. Soc. Jour.*

BŒHMERIA nivea.

Prospects of Rhea in Assam.

BURMA.

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"On the other hand, there is no probability that the cultivation of rhea will ever be undertaken on a large scale by the Assamese *raiyat*, owing to the labour involved in the separation of the fibre by hand, and to the fact that any machinery or process by which it could be more easily extracted would be beyond the *raiyat's* means. The present condition of the Assamese peasant is such that he is not compelled to engage in any laborious occupation in order to obtain a subsistence, which is all that he requires, and even the trouble of preparing jute for the market has been sufficient hitherto to deter him from the cultivation of that crop, in spite of the large profits which it would probably yield him. So far as present indications go, it appears that, if rhea cultivation is ever to become an important industry in Assam, it must be established there, like the tea industry, by European capital, with the help of imported labour. Before investing capital in this speculation, it would be well if parallel experiments could be made with Bœhmeria nivea and Bœhmeria tenacissima, in order to decide which variety thrives best in the Assam climate."

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BURMA.

Mr. A. H. Landers contributed to the Agri.-Horticultural Society of India a paper on "The Vegetable Products of the Shan Country," in which he makes mention of this plant. Mason (*Burma and Its People*) gives a brief account of the cultivation of the plant, but in Theobald's Edition (*Vol. II., 265*) the remarks offered might be said to read like the prospectus of some company owning a patent process. There is hardly a sentence in the passage that can be regarded as having any reference to Burma or in fact to India. The statement is made that the ribbons of bark, stripped off in a particular way, would fetch from £60 to £120 a ton in England.

Price of Clean Fibre. *Conf. with paras. 3-4, 9, 43, 65, 81, 83, 84, 124-6, 136, 140.*

104. ***Recent Investigations.***—The Inspector General of Forests has obligingly placed in my hands copies of letters that have passed between himself and the officers of his Department, in Burma. Some of these contain useful additional information, though it must be confessed the subject has as yet been far from satisfactorily investigated. I may give the following as specially interesting:—Mr. J. Copeland, Deputy Conservator of Forests, Mandalay Division, records in his diary the following note:—

Mr. Copeland's Report

Reputed Exports to China.

"Saturday 22nd, marched to Nanlan about 10 miles. This is the place where it was reported that the rhea was cultivated on a large scale, quantities of it being exported to China. Small plots of the plant are found attached to several houses in all the villages on this plateau, but it is only cultivated for domestic use and not for sale, as a general rule, though small quantities of it are sometimes procurable in the Nanlan Bazar where it fetches as much as 8 annas a *viss*.* It is propagated from root cuttings which take readily in the rains, and not much care requires to be taken of the plants. It grows to a height of 4 feet and over. The fibre is separated by hand, the stalk being previously scraped with a *da* to clean it. It is used for making into a sort of rough twine. The *thugyi* says that if there was any sale for it, the people would be glad to extend its cultivation. Nanlan is only 30 miles from Thibaw, and will be within 20 miles of the branch railway to Kyatsi Mansam, so it is worth while to encourage the Shans to extend its cultivation."

Price of Fibre.

Bark Scraped off. *Conf. with paras. 72, 75, 79, 80, 82, 86, 98.*

105. It will also be instructive to furnish here two letters by Mr. Carr, Officiating Deputy Conservator of Forests, Mandalay Division (dated 25th August and 13th October 1896). His reference to the so-called "wild rhea" of Burma is interesting since it has been from similar remarks regarding Assam that the idea of **B. nivea** being indigenous have doubtless proceeded.

Mr. Carr's Communications

* 1 viss = 3 68 ℔ Av.

SHAN STATES.

"In reply to your No. 618-34—A-3, dated the 16th June 1896, I have the honour to state that a species Bœhmeria which from a comparison with the plants sent up from Rangoon I take to be **B. nivea**, is already cultivated on the Shan Plateau There was a field of *gun* (by which name the plant is known there) in the old village of Maymyo, but one of the new roads which is being constructed cut right through it, and all the plants were destroyed. I found only one or two shoots left, and they would scarcely do as botanical specimens.

Introduced from China.

"I was informed that the plant was introduced from China, and is cultivated in several places in the Shan States especially by the Palungs. The bags in which the latter carry their betel boxes and other odds and ends are made from the fibre. It is cultivated from cuttings which take easily. I may mention that the plants sent from Rangoon and put down in the Forest bungalow compound at Maymyo have all taken root and promise to do well.

Trade to China not Confirmed.

Name *gun* sometimes given to Cotton.

"I have not been able to obtain any confirmation of the report that in Manig Kanig the fibre is pressed into bales and sent across the Salween to China. There is a trade with China in fibre of some sort, but it is not known yet whether it is rhea. The Forester at Maymyo has been instructed to proceed to Nanlan and bring specimens of the fibre and the plant producing it Mr. Johnson, of the Bombay, Burma Trading Corporation, Limited, who recently visited Yatsank, a neighbouring State, says that when he asked for *gun* he was shown the cotton, and that the people were ignorant of any fibre-producing plants except the *Shaws*"

A Wild Rhea.

Is not Plentiful.

"With reference to your letter No. 1217-34—A-2, dated the 26th August 1896, I have the honour to submit the following additional information regarding rhea The *gun* species is almost certainly Bœhmeria nivea, but another species called by the Burmans *Hpetye** is found wild in the neighbourhood of Maymyo and, I am informed, all over the Southern Shan States The *Hpetye* is a stinging species. The fibre is not considered to be as good as that of *gun* and is not used much by the Burmans. The Palungs, however, are said to mix it with *gun* and use the two together although they prefer *gun*. *Hpetye* is said to be fairly plentiful, while considerable difficulty has been experienced in getting *gun* fibre, only about 4 or 5lb having been obtained up to date.

Uses of Rhea.

"*Gun* fibre is used by the Palungs for making their small bags, but except for this its principal local use is for sewing leather sandals. The makers of these sandals pay R1-4-0 per *viss* for the fibre. At this rate a ton would cost approximately £45 sterling bought locally, and as the

* The plant here mentioned was forwarded to me and proved to be Girardinea heterophylla and consequently was not Rhea.—*G. Watt.*

BŒHMERIA nivea. | Rhea employed in Sowing Sandals.

BURMA.

Price of Fibre.

Conf with paras. 3, 4, 9, 34, 43, 65, 71, 83, 84, 103-104, 124-126, 136, 140.

Rhea Fibre Treatment Company only offer £7-10-0 per ton, delivered in Rangoon, it seems unnecessary to discuss the question of carriage.

"As rhea fibre is light and bulky, freight would probably be at a high rate and to obtain it locally at £6 per ton is equivalent to 6 *viss* for R1 or at two-fifteenths of the present rate Of course with an extended scale of cultivation and machinery the cost of production might be considerably lessened, but it scarcely seems possible that it can ever be profitably worked in Burma at a selling rate of £7-10-0 per ton, delivered in Rangoon.

Botanical Specimens.—"*I forward herewith botanical specimens* of both *gun* and *hpetye* as well as some fibre of the latter species. Owing to defective preserving arrangements and damage during transport to Mandalay the specimens are very poor."

Manufactures.

Conf. with paras. 14, 54, 77, 102, 204.

106. ***Manufactures.***—Mr. Carr's allusion to the use of rhea fibre woven into small bags recalls Colonel Burney's description as also the very similar bags which on the Assam Frontier are invariably made from the *Ban-riha* fibre (**Villebrunea integrifolia**) and never from rhea So also the Jabaka and even Angami Nagas employ the fibre of **Girardinea heterophylla** mixed with *Ban-ríha*, cotton or other textiles But if there be no mistake as to the fibre being employed by the Shan tribes this is the only mention of rhea being woven into fabrics in India.

107. Mr. Carr's allusion to the makers of leather sandals employing the fibre for sewing thread, brings to mind Linschoten's very curious description of the "Herbe Bengalen" which, he tells us, was employed for sewing quilts A modern use of rhea is the preparation of shoe-makers' thread, a purpose for which its great strength very highly recommends it. Linschoten says:—

Linschoten's Herbe Bengalen Written, 1596.

"They do most cunningly stitch their coverlits, pavilions, pillows, carpets, and mantles." "Likewise they make whole pieces or webbs of this herbe sometimes mixed and woven with silk, although those of the hearbe itself are dearer and more esteemed, and is much fayrer then the silk. These webs are named Sarrijn, and is much used and worn in India, as well for men's breeches as dublets, and it may be washed like linnen, (and being washed) it sheweth and continueth as faire as if it were new."

Shawls and Saris.

Conf. with paras 14, 77.

Bhagalpur Admixture with Silk.

Conf. with para. 54.

I have already alluded to the report that the people of Bhagalpur formerly mixed, and, perhaps, to this day still mix, rhea with silk. That fact and the above reference to the textile use of the fibre in Burma, are the only instances that I have been able to discover of

BURMA.

the fibre being put to any other purpose than that of making fishing lines and nets Linschoten's remarks, though they seem to apply more directly to rhea than to any other fibre, are open to the criticism that it is difficult to see how a fibre once so extensively employed and so highly valued, could have come to be disused. But whatever the fibre was, it is not now employed in the way he describes, so that it is just possible it was rhea, and that a more extensive knowledge in this fibre and wilder cultivation prevailed formerly than at the present day.

Probable Decline in Use during Modern Times.

CULTIVATION IN MADRAS AND MYSORE.

MADRAS.

108 Although in South India there would appear to be no Native industry in growing this plant, it has been experimented with on a large scale by several European gentlemen and companies. In fact it might also be said that the possibilities of the crop have been more fully tested in South India than in any other part of this country.

109. The Agri-Horticultural Society of Madras has for many years taken an active part in forwarding the enquiry, and at the Government Experimental Farm of Saidapet, the plant has been repeatedly cultivated though only to a small extent. But the object of this report, being mainly to afford information regarding the crop in the districts where it is regularly grown by the Native cultivators I can at most indicate the chief sources of my information and the final results that have been obtained in Madras.

Extensively Experimented with.

110. ***Glenrock Company's Experiment.***—One of the oldest and, perhaps, the most important experiment of this nature was that undertaken by the Glenrock Company, Ld. Mr. Samuel Jennings has given (*Agri-Horticultural Society of India, Vol. VII (n s.), pp. 307-323*), a full account of the Company's efforts which will be found highly instructive and should be consulted. Mr. J. W. Minchin was in 1884 brought out from England to manage the Glenrock Company's contemplated Rhea Plantations, and on the way to this country he paid a visit to Algiers in order to see the method pursued by the great French Pioneers in this industry. Mr. Minchin has been good enough to favour me with some of the practical results obtained and the opinions he formed of the experiment, during his connection with the Company. It will, perhaps, be unnecessary for me to quote the correspondence in full form, but I have Mr. Minchin's authority to make any use I please of the particulars supplied, and

Mr Minchin's Report.

MADRAS.

shall therefore give the more important points which he has made out :—

Acreage Cultivated.

"I was employed, he writes, by the Glenrock Company, Ld., to cultivate and treat rhea on their property at Pandalur in South-East Wynaad. The Glenrock Company also undertook the cultivation of rhea at Kullar in the Bhowany Valley, about 5 miles from Mettapollium. Some 400 acres of rhea were planted in the forests on the slopes of the ghats below Pandalur village and about 100 acres at Kullar.

Irrigation Essential.

111. ***Yield of Stems.***—"The growth of the rhea was all that could be desired ; as many as six cuttings of stems were obtained in the year, where assistance could be given to the plants by irrigation. Without irrigation at Pandalur three cuttings were obtained between the months of June and November, during which months the rainfall is about 100 inches in all. The best outturn from one measured acre in 1886-87 under irrigation during the dry months was six cuttings :—

Best Outturn. *Conf. with paras. 34, 71, 79-80, 81, 83, 84, 85, 87, 89, 96, 99-100, 127, 157.*

1,384lb of stems	(8	stems to the lb.)	about	11,000 stems.
2,028lb "	(	ditto)	"	16,000 "
4,446lb "	(5	ditto)	"	22,000 "
4,904lb "	(6¼	ditto)	"	30,000 "
3,660lb "	(9¼	ditto)	"	25,000 "
1,605lb "	(15	ditto)	"	24,000 "
18,027lb (8 tons) weight of stems in the year about				128,000

112. ***Machinery Employed.***—" This was an excepti[illegible] field with facilities for water. The stems were treated in Dea[illegible] wood's Machines, but a considerable loss of ribbon was sustain[illegible] by the Fremy system of steaming and removing the cuticle [illegible] Small portable boilers on wheels were used, which followed th[illegible] who were cutting the stems along roads through the cultivati[illegible] steam was turned into closed wooden boxes into which the st[illegible] placed The skinning by hand was a slow process, but the rib[illegible] saved.

Steaming Process. *Conf. with paras. 64, 82.*

Drying Ribbons. *Conf. with paras. 13, 43, 75, 80, 82, 103, 111.*

113. ***Drying Ribbons.***—There was, however, great diffic[illegible] drying the ribbons during the rains in the Wynaad when alone th[illegible] grow except under irrigation. Drying rooms were made with [illegible] pipes and exhaust pans for drawing off the moisture.

Did not Pay.

114. ***Period of Experiment.***—"The cultivation and experiments were continued by the Glenrock Company from the beginning of 1884 until 1889, say five years, but the fibre obtained at the price ruling, did not pay for the cost of production, and accordingly the cultivation was given up.

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115. ***Plants Available.***—"The rhea planted in the Glenrock Company's Forests is still there contending with the jungle growth although it has been deserted for the last six years, and any amount of roots and plants can be obtained from that Company for future experiments."

FIVE YEARS' EXPERIMENTS.

Survival of Stock.

Conf. with paras. 18, 23, 29, 43, 60.

In reply to a communication in which I asked for certain additional information, Mr. Minchin was good enough to reply as follows:—

116. ***Climatic Conditions of Wynaad.***—"I think the soil and climate of the Wynaad were very suitable to the cultivation of rhea. Three good cuttings were obtained without irrigation during the rains There is always very little rain for four or five months of the year. It may be that a more equable distribution of the rain might give a fourth cutting.

Irrigation.

Conf. with paras. 96, 97, 110, 127.

117. ***Outturn Exaggerated.***—"Every facility was provided by the Glenrock Company for the treatment of the rhea and every opportunity for the cleaning and disposal of the filasse at the full price available. I consider that the figures on which the production and outturn of rhea ...itherto been based are very greatly exaggerated. Calculations years ...e most part been made on a quite insufficient basis."

Conflicting Returns.

Conf. with paras. 71, 99, 123, 131, 158.

Governm... Mr. Montgomery, of Kangra Valley, bases his calculations on the repeated ...om 1,000 stems which were all over 6 feet long and weighed over of this r...each. On this he gives 1,000lb of ribbons as his yearly crop in the ...e writers make their calculations on the produce of a square I can ... land: others on the produce of a square yard of land; still final re...n the number of stems from one plant.

Montgomery's Calculations.

Conf. with para. 155.

11...t the outturn of ribbon from weight or number of stems treated, and, ...s on the condition of the stems, how long cut, their age and condi- under ...hen cut.

Varying Factors.

... ***Proportion of Water.***—"Dr. Forbes Watson in his Report on given ...in 1875, calculates that the proportion of water in the green stems pp. ...s from 75 per cent. to 80 per cent. I found during the heavy rains four ...he proportion of water was as much as 90 per cent. of the weight of was ...n stem

Conf. with para. 121.

Con...20. "*The only statement that I have seen of the quantity of stems* cou...lly obtained from any considerable area is that in Colonel Hyde's by t...t on Greig's machine in 1872 when 7,360lb of stems was cut from ...3 acres of ground in the Saharanpur Gardens. But even that acreage was not accurately ascertained. Colonel Hyde assumes the crop to be 2 tons of stems per cutting per acre.

Colonel Hyde's Calculations.

Conf. with para. 170.

121. ***Variations in Yield.***—"Even with irrigation the different cuttings will not be alike. The outturn of ribbons to the weight of green stems treated also varies very greatly. Mr. Montgomery calculated this at

Age at which Cut.

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Steam Decortication. *Conf. with paras. 64, 82.*

Percentage of Ribbons.

Percentage of Water. *Conf. with para. 156.*

6½ per cent. from large stems and 3½ per cent. from small stems. Stems will not all grow to the same size. They must be cut when they begin to brown at the base whatever their size. Colonel Hyde from Greig's machine got 2¾ per cent. ribbons. In Algiers and the South of France, Mr. Favier states that 10 per cent. of ribbons is obtained from the green stems by the Fremy steam decorticating process. These are much dryer climates than the Wynaad—there is probably a much smaller proportion of water in the green stems. The Glenrock Company obtained only about 3½ per cent. ribbons by the Death and Ellwood machine and from 5 per cent. to 6 per cent. ribbons by steam decortication, according to the season of the year.

122. ***Replanting.***—"Rhea is a most exhausting crop and will require periodical replanting and heavy expenditure in manure to keep it up.

Dr. Watson's Estimate. *Conf. with para. 131.*

500lb Filasse per Acre.

Price. *Conf. with para. 136.*

123 ***Yield.***—"I consider that Dr. Watson's estimate of 750lb of ribbons per acre the utmost that can be obtained per annum from rhea and *that* quantity only under *very high cultivation. These 750lb ribbons should* give after degumming about 500lb of clean filasse which I think is worth now one shilling per lb* if it could be supplied in quantity.

124. ***Price too Low.***—"Unless the market is prepared to give up to £70 per ton for rhea ribbons, I do not think there is any inducement to undertake the cultivation

125 ***Spinning and Weaving.***—"The long-staple rhea filasse will not be used except with machinery especially adapted for it, and the new machinery will not be erected until a large and regular supply can be obtained. A large expenditure of capital in the cultivation will be necessary before a market for the filasse can be assured, and the manufacturers must give a very long price for the raw material when available. I was informed by a large manufacturer that if I could supply 50 tons of the filasse per month, he would contract to buy it at eight annas per pound† in India. But it would require an area under cultivation of 3 to 4,000 acres to ensure a yield of 50 tons a month.

Capital Required. *Conf. with para. 101.*

A Large Contract.

Price. *Conf. with paras. 3-4, 9, 43, 65, 71, 81, 83, 101-5, 114, 125, 140, 184.*

126 ***Comparative Cost of Jute and Rhea.***—"The price now talked of £7 per ton for ribbons will obtain no supply *(see para. 184).* Jute, as Dr. Watson reports, gives 1,500lb of fibre per acre in one cutting and is worth from £12 to £20 per ton. Rhea will give half this amount in several cuttings and with very much greater cost in cutting, treatment and cultivation.

"I consider that the future of rhea depends on the price that it may be worth."

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* Mr. Minchin's letter was dated 12th August 1896.

† This might be said to be the average price at which the clean fibre can be procured in North Bengal and Assam, *viz.* R1 a seer.—*G. Watt.*

127. ***The Reading Rhea Fibre Estate.***—Another experiment at rhea cultivation on a fairly extensive scale was undertaken in South India, namely, by Messrs. James Finlay & Co. at their Reading Estate. This was started in 1887 and discontinued in 1894. It was under the management of Mr. W. Rhodes James I am unfortunately not in a position to afford full particulars regarding this experiment, but I understand that the highest yield from one acre in one cutting, was 64 cwt. 3 qrs. of green stems The *average yield came to 1,200lb green ribbons per acre per crop*, on what was called the bed system of cultivation On the open system an acre yielded 2nd crop 2,056lb and 3rd crop 2,685lb green ribbons.

SEVEN YEARS' EXPERIMENT.

Highest Yield Conf. with para. 111.

"It was, I understand, found that dry ribbons ran to about 20 per cent of the weight of green ribbons, and dry ribbons ran about 7 per cent, of the weight of green stems.

Percentage of Ribbons.

"Irrigation and manuring were found indispensable "

Irrigation. Conf. with paras. 97, 110, 116.

128. ***Mysore***—Mr. John Cameron has recently published a *Memorandum on the Rhea-fibre Plant* which no doubt incorporates experience gained at the Mysore Government Botanic Gardens. The following passages may be here taken from Mr. Cameron's report:—

"***Propagation.***—*To secure seed, the plants cultivated in this* country require very special treatment. But even then the supply is usually scanty and precarious. It is fortunate, therefore, that the rhea plant is so readily propagated by the division of its tubers, offsets and stems. The best plan is to lift a matured plant bodily for the purpose of division. The tubers, which resemble small potatoes, can then be dibbled into the nursery separately, the larger ones possessing several 'eyes' can also be cut into 'sets' as in the esculent just referred to. Then by careful handling, a sturdy root-stock can be separated into many parts, each having a little root and stem Finally, the cane or stem can be reduced into cuttings of 5-6 inches in length The best cuttings are obtained from the matured wood, but treated under glass, in fine sand, the tender or herbaceous portions of the stem will also take root. By the above methods many thousands of plants can be raised from even a limited stock. But to ensure success it should be done during the growing season. In this climate, old stools and freshly rooted slips are practically as hardy as nettles, so that once established the plant is propagated without risk or even much trouble. The botanic gardens possess several thousand plants from which young stock can be raised in quantity. Rhea has also been domesticated to some extent in the coffee districts, so that, even in the absence of seed, we have ample material to propagate from"

Production of Seed. Conf. with paras. 17, 28, 31, 76, 81.

Propagation by Root Cuttings. Conf. with paras. 24, 69, 79, 83, 86, 92, 101, 104.

Domesticated in the Coffee Districts.

129. "***Sites for Natural Growth***—In Mysore, the hill country included in the districts of Hassan, Kadur, and Shimoga, affords the position

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MYSORE.

Best Climate.

and climate best suited to the hardy growth of rhea; and in the most favourable situations it is not improbable but the plant would run wild to some extent. What is really required in this new product is its possession in great quantity raised at a nominal cost."

Available Land.

130. "*Sites for Cultivation.*—It follows that where the plant will thrive without help it will also be the most productive under liberal cultivation. Extensive areas of comparatively open forest land having a good head-flow of water from some perennial stream would answer well, providing that the soil is fertile and open. Good drainage is a very essential condition of this culture, so that the sloping sides of hills and *sholas* might be preferable to lands situated on flats and in basins. The annual rainfall should not be less than 50 inches and would not hurt growth if it reached 100. Wet lands on the sides of rivers and canals bordering the Malnad would only be suitable if they are porous and easily drained. But in all probability the existing wet crops are much more profitable than rhea is ever likely to become under similar conditions of cultivation.

Humidity Required.

Existing Crops more Profitable.

Soils. *Conf. with paras. 46, 49, 50, 62, 78, 91.*

131. "*Cultivation.*—Virgin forest soil, and good loam with a liberal admixture of sand, are equally suitable for the vigorous growth of rhea. But there must be no stagnation of water, hence it is necessary that plots demarcated for planting should be thoroughly opened by the plough. This is best done at the close of the monsoon when the surface herbage can be ploughed in and left to rot during the dry season. At the bursting of the south-west monsoon, another thorough ploughing will be needed to make the surface soil soft and workable. Rooted plants of rhea can then be put out in the field at 3-4 feet apart. The crop will not be a full one during the first year, but in the second, third and fourth years it will be full. Under good cultivation the young plants throw out many suckers or offsets, and after 12-15 months of continual growth the intervening spaces will be nearly full of stems of various sizes. After the fourth year the growth becomes stunted and the fibre deteriorates in length, texture and value. When this takes place the field has to be entirely broken up and a new one laid down. But should it be preferred to break up and resuscitate the original field, a large amount of manure would have to be applied in the first instance and at reasonable intervals subsequently. After the first planting, field operations consist of weeding, hoeing, and removing the manured stems."

Ploughing.

Planting.

Transplanting.

Manure. *Conf. with paras. 70, 79, 83, 86, 91, 95, 96, 100, 127.*

Weeding and Hoeing.

Irrigation.

Number of Cuttings.

"With continual growth all the year round supported by irrigation during the dry months, an average yield will be three cuttings, but under exceptional circumstances even four cuttings may be obtained."

132. "*Possible Yield per Acre.*—The outturn of fibre per acre differs according to climate and situation. But the best average results

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under proper cultivation are not likely to exceed eight tons* of ribbon (stripped bark) per annum At any rate a larger quantity than this should not be expected from Indian cultivation."

MYSORE. Yield per Acre. *Conf. with paras. 34, 71, 79-80, 81, 83, 84, 85, 87, 89, 96, 99-100, 111, 121, 123, 127, 158.*

133. "***Present Market Value.***—Bales of assorted ribbons are now purchased on contract by a home company at £10 per ton. But it is very doubtful if this price would be maintained in the open market. Any quotation of value at the present stage of the industry must therefore be more or less unreliable. But supposing the yield in India is only six tons per annum and the market value £5 per ton, an acre of Rhea would still be worth £30 to the cultivator."

Minchin Fixes Maximum Yield at 750lb. an Acre.

134. ***Future Experiments***—It will hardly be necessary for me to furnish other opinions regarding rhea cultivation in South India It will doubtless be freely admitted that the experience gained by the Glenrock Company, though unfortunate, must be of the greatest value as a record for future guidance. Mr. Minchin's opinions are completely substantiated by the figures furnished by him The regret naturally occurs that the enterprising Indian Pioneer Company ever attempted the crop in the Wynaad. There would seem to be no doubt that to dispose fully of the question of India's possible participation in the world's future supply of this wonderful fibre, one or two commercial undertakings on the scale of the Glenrock experiment are essential within the region where the plant has for centuries very possibly been grown by the people of India It will be time enough to think of experiments in other parts of India when it has been proved that North Bengal and Assam can produce the fibre at a profitable rate

Wynaad unfavourable.

Rhea Region. *Conf. with paras. 66-68.*

135. ***Maximum Acreage Yield***—There has been no experiment either in North Bengal or Assam that can for a moment be compared with the efforts over which Mr. Minchin presided His experience, so far as India is concerned, must be regarded as the only one with which the public have been favoured, that can be accepted as affording definite indications for future guidance. But if the available information that has been reviewed in the foregoing pages, regarding Bengal and Assam, can be trusted, there would seem little doubt that the yield in these provinces is considerably higher than that obtained by Mr. Minchin. Colonel Hannay had a fairly large plot of land under the crop in Upper Assam, and his ultimate conclusion appears to have been that a yield of about 12 maunds of clean fibre to the

Experiment on a Large Scale Essential.

Yield. *Conf. with paras. 34, 71, 79-80, 81, 83, 84, 85, 87, 89, 96, 99-100, 111, 117, 121, 123, 127, 131, 158, 171.*

* Surely Mr. Cameron means 8 maunds, see para. 99.—*G. Watt.*

BŒHMERIA *nivea.*

Conclusions Regarding South India.

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acre was not impossible Several cultivators assured me when I questioned them on this point, that they obtained from 8 to 10 maunds an acre Mr. Monahan, the Director of Land Records and Agriculture in Assam, hesitates, however, to accept a higher yield than 640℔ of scraped and cleaned fibre.

Price. *Conf. with paras. 3, 4, 9, 34, 43, 65, 71, 81, 83, 84, 103, 104, 105, 114, 124, 126, 140.*

Future Prospects, etc.

136. ***Filasse, not Ribbons, Produced.***—Throughout Assam and Bengal, (as I have in several places in the above review stated), the Natives produce filasse not ribbons They sell that article at a price that averages from 6 annas to 2 rupees 8 annas a seer (=2℔) Mr. Minchin tells us of a merchant who was willing to contract for a large monthly supply of filasse at 8 annas a pound. It would thus appear probable that cultivation on a large scale and with the modern facilities for cleaning the fibre, might undersell the present native price, in other words that a price of 8 annas a pound for filasse might be remunerative. Indeed it will be admitted generally that this statement is the most hopeful part of Mr. Minchin's otherwise very unfavourable report.

CULTIVATION IN PANJAB.

137. ***History.***—There is hardly anything further to say regarding the rhea cultivation in this province than has appeared already in the *Dictionary of Economic Products;* namely, the various reports on Mr. Montgomery's experiments.

Mr. Montgomery's Arrival in India.

On the 12th November 1894 I paid a visit to the Ram Bagh plantation in Kangra, in order to inspect what remained of Mr. Montgomery's farm. I had the pleasure to meet his widow—a lady then over 80 years of age (and since deceased)—from whom I learned many interesting details of the great struggle made by Mr. Montgomery and the numerous disappointments he had had to endure Mr. Montgomery came to India in 1862 in the same ship with Mr. (afterwards Sir Robert) Egerton, at that time Settlement Officer in Gurdaspur, while Mr. P. Egerton was Deputy Commissioner in Kangra. Mr. Montgomery was persuaded by Sir Robert to commence his rhea experiments in Kangra, and the two gentlemen accordingly made their way up the Indus together.

Early Disappointments

138. The firm Mr. Montgomery came out to represent failed shortly after his arrival in India and he was thus left single handed. After much trouble he succeeded in procuring from China a small supply of seed (most of which failed to germi ate) and six live plants,

at a cost of R300. From these his plantation was ultimately stocked and large supplies were subsequently sent to the Saharanpur Botanic Gardens, to Assam, to Mr. Minchin in the Wynaad, to Baroda, to the Deccan, and even to the Sultan of Johore.

MR. MONTGOMERY'S EXPERIMENTS.

His Excellency Lord Mayo paid a visit to the Ram Bagh three months before his death. Mrs. Montgomery could remember every detail of that inspection and the pleasure Lord Mayo took in studying the cultivation of the plant and witnessing the extraction of the fibre from the stems.

139. ***Fibre Separated by Chinese Workmen.***—Fortunately for Mr. Montgomery there were Chinese workmen employed at the time at the Government Holta Tea Estate in Kangra. Some of these men were lent to him, and on their arrival at the Ram Bagh they expressed astonishment at seeing the *Chu Ma* plant which they at once recognised and named. They stripped the shoots of their leaves and, laying the canes flat on a board, proceeded to scrape off the green bark, all the while that clean water was being made to play along the board. It was through these Chinamen that Mr. Montgomery ultimately learned many details of cultivation and the manipulation of cleaning the fibre.

Chinamen Recognised the Plant.

Demonstrated Method of Cleaning Fibre.

Water Used in Cleaning. *Conf. with paras. 39, 64, 72, 82, 100.*

140. Samples of filasse sent from the Ram Bagh during its early years fetched as much as £120 a ton, and Mrs. Montgomery showed with pride a collection of yarn and fabrics that had been spun and woven from her late husband's hand-cleaned filasse (since purchased and deposited in the Economic and Art Museum, Calcutta) But in spite of every effort Mr. Montgomery failed to obtain a remunerative price for his fibre and the cultivation of the plant remained as it is to-day in an experimental stage.

Failure Due to Price Paid for Fibre. *Conf. with paras 3-4, 9, 43, 65, 81, 83, 84, 103, 120.*

141. Mrs. Montgomery after explaining these historic incidents of the Kangra experiment then conducted me over the plantation, which ever since her husband's death she had continued zealously to supervise. On the questions of transplantation and exhaustion of soil she said that formerly every now and again the plants were dug up, the old wood rejected, and the fresh shoots replanted on the same ground. Manure she could not afford to give, but the soil in Mrs. Montgomery's opinion was so fertile that there was hardly any occasion for manure. One field had not been taken up during the past sixteen years, and yet the shoots on it were fully five feet in height during my inspection

Transplanting and Exhaustion.

Not Transplanted for 16 Years. *Conf. with paras. 23, 95.*

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in November. Thus for over 30 years the Chinese plant has been grown on the Ram Bagh without showing either degeneration of stock or exhaustion of soil.

Situation of Ram Bagh.

142. The Ram Bagh is a fertile bit of rich loam, situate down in the very bottom of the valley, and only a foot or two above the level of the river, but the various rhea plots are well shaded by avenues of fruit and other trees. Irrigation and even silt manure is available whenever required.

Subsequent to the date of my visit to Kangra I had the pleasure to receive several letters from Mrs. Montgomery, of which the following passages may be published in this place:—

"Shortly after you were here I had all cut down that you saw gone to seed, none of the stems were more than five and six feet long and very thin, from the best of them I had the fibre stript, it was very strong and good for rope and string, but not what I would send anywhere as a good specimen of long dry fibre."

Long Ribbons of Clean Fibre

Conf. with paras 13, 43, 75, 82, 103, 111, 121, 132, 135.

"On the other parts where you saw the plant fresh and green the stems were short and went to seed, then unfortunately the *guddees* sheep and goats got on the ground and ate all the leaves and tops of the young stems Though fresh ones have sprung up and are growing well, I do not think there will be any fit for the long ribbon-like fibre, such as was formerly prepared here by merely scraping off the gummy matter using only cold water and no chemicals of any kind. In this way a beautiful white fibre can be obtained without machinery at a trifling expense, and Kahars here gladly purchase it at R1 per seer."

Price of Fibre Locally.

"To produce long thick stems for good fibre, all the China-grass I have requires to be transplanted; roots or cuttings even, planted 2 feet apart, soon outgrow that space. It is more than 16 years since any of my plants have had anything done beyond being cut down and the fibre used merely for rope and string. If my land could be ploughed *at once*, the roots separated and replanted, there would be a good crop of long stems by the end of May, but this I cannot do. I am not inclined to incur the expense as I am far too old now to be able to see to the work being done properly."

Nothing Done for 16 Years.

143. "I should be glad to meet with a purchaser for my property which is freehold, it was purchased before Lord Canning's Act was repealed. Great expense had to be incurred to root up all the trees of milk bush, cactus, etc., and to line out and build retaining walls, to terraces and lay out water channels, before the China-grass could be planted. Cuttings and seed had to be obtained direct from China, but when planted the climate of Kangra and the locality of the Ram Bagh was found to be

Preparatory Operations.

admirably suited for the cultivation of the China-grass, stems of 10 and 12 feet in height growing rapidly and giving 3, 4, and sometimes 5 crops in a year."

MR. MONTGOMERY'S EXPERIMENTS.

"The plant is so readily propagated by division of roots and cuttings that almost any amount of land could be stocked, from a single plant. I have made 170 which at 2 feet apart outgrow that space in 2½ to 3 years."

Stems often 12 feet high and 3 to 5 Crops a Year. One Root Affords 170 Cuttings.

"Some years ago I was requested by Mr. A. O. Hume to send a ton of dried stems. I had them cut, dried and sorted, so, sent all of an equal length, viz., 12 feet."

Conf. with paras. 39, 69, 79, 83, 86, 92, 102, 104, 128.

"I have a Brasier's patent fibre-cleaning machine here, but some years ago fibre prepared by it was valued at £40 per ton, while that cleaned by the Chinese method, was worth £120 the ton."

Valuations of Fibre.

"I have made many experiments and found various methods of extracting the fibre cheaply which I would gladly show to any one wishing to purchase my property."

144. ***Mr. Montgomery's Report.***—The following, being Mr. Montgomery's last report, may be given here since it has been repeatedly alluded to by many other writers whose opinions have been quoted :—

Report of China-Grass Cultivation and Preparation for Export.

"In submitting, for the information of the Government, the results of my experience in the cultivation of this valuable plant, I wish pointedly to note that my remarks refer solely to that variety of the plant cultivated and known in China under the appellation '*Tchow Ma.*' My stock of plants has been derived from seed procured with great difficulty from that country in 1863

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145. "(2) Whether the variety of the plant known in Assam as 'Rhea,' or that known as 'Rami' in the eastern islands, is identical with the Chinese plant, I do not venture to offer an opinion The Government of India have apparently adopted the former appellation 'Rhea,' in designating the fibre, the American Government have adopted the latter 'Rami.' I have not had an opportunity for comparing growing plants of each variety with mine, but I have had many specimens of fibre from each supplied to me, and there appear to me well-marked distinctions between the three, in colour and texture of the fibre.

Chinese Plant.

146. ***Kangra—Plantation Established in 1863.***—"(3) At the time I succeeded in establishing the growth of the plant here (1863-64) the tea plantation at Holta was the property of Government, and several Chinese were then employed there. These men recognized my plants with much surprise, and showed me the Chinese method of separating the fibre.

Chinamen Recognise the Plant.

BŒHMERIA nivea. Mr. Montgomery's Report.

PANJAB.

Difficulty with Seed. *Conf. with paras. 17, 28, 31, 79, 83, 128.*

147. ***Propagation*** (4) ***By Seed.***—"This course must be adopted in some cases, when the germ of the plant has to be carried over great distances; but probably much disappointment will attend the result. To obtain the seed great care is requisite, and a favourable atmospheric season. For this purpose young spring shoots should be carefully reserved in a well-sheltered position. These plants should receive special care and be well manured. During the rainy season they must be kept thoroughly drained, and after that has passed, the ground should be carefully loosened round the plants. If the rains cease early in October, a fair amount of seed may be obtained; but as far as I can judge no amount of care can ensure success, so much depending on the season—a dry one being most favourable for the full development of the seed. The only method of sowing which I found successful was on a gentle hot-bed, under glass, in March and April; the seed scattered over the surface, covered very thinly with sifted earth, and carefully shaded from the sun, until the plants were about three inches high, when sunlight may be gradually admitted. When sufficiently strong, they should be planted out a foot apart every way."

Cultivation for Seed.

Dry Season Favours Production of Seed.

148. (5) ***By Cuttings of the Stems.***—"The stems should be spring-grown ones, allowed to ripen well and not cut until duly ripe. Then divide the ripened portion of the stem where the cuticle has turned fully brown into short lengths, each including three eyes or buds. Cut a quarter of an inch below the bottom bud and as much above the top one, and plant with the centre bud level with the surface. If the weather be damp and cloudy, they will readily strike root, otherwise they will require shading for a week or ten days, the soil being kept moist. As with seedlings, I find a foot apart every way the most advantageous distance, as very few shoots are thrown up the first year."

By Stem Cuttings.

Distance Apart

149. (6) ***By Division of the Roots.***—"This is by far the most advantageous and profitable method. The plants for this purpose should be three or four years old. After gathering the spring crop, dig up each plant carefully and remove the earth from the roots. I generally put the mass of roots into running water for a short time; this cleanses them thoroughly, and enables the gardener to see his work clearly. The tuberous portions of the roots will be found to show a large number of eyes similar to those on a potato. From these carefully separate portions each containing five or six eyes, let the cuts be clean and reject all fibrous and decayed matter. Expose these sets to the sun for a couple of hours to dry the surface of the wounds, and then plant six inches deep, and at the full distance of four feet apart every way. In this way two good crops will be obtained from them the first year."

By Root Cuttings. *Conf. with paras. 39, 69, 79, 83, 86, 92, 102, 104, 128, 142.*

Method of Preparing.

150. (7) ***Soil and Situation for Plantation.***—" A rich loam suits the plants best, but they will grow in any kind of soil, provided a full supply of moisture be available combined with thorough drainage. The latter is emergently required, particularly during the rainy season, as, should the land be retentive and become swampy, the plants will wholly decay in a very short period. If the land be poor, a liberal supply of manure is requisite, otherwise the stems will be short and weak, yielding scarcely any fibre. In no part of Upper India can the plant be successfully cultivated unless water for irrigation be available during the dry season. The facilities for obtaining an ample supply of water, combined with the moderate temperature at all seasons, renders this district particularly favourable to the plant."

MR. MONTGOMERY'S EXPERIMENTS.

Soil.

Conf. with paras. 46, 49, 50, 62, 78, 91, 131.

Swampy Land Unsuitable.

Irrigation Indispensable.

Conf. with paras. 97, 110, 116, 127, 130.

151. (8) ***Cultivation.***—" Should the land have been stocked with seedlings or cuttings (paragraphs 4 and 5), then in the following spring, after having reaped the first crop of available shoots, every other plant should be transferred to fresh ground, and put down at two feet apart. The following year the same course should be pursued, taking up each alternate root and replanting at four feet apart. After this the plants may well remain undisturbed for four years, hoeing well between after each crop, clearing away weeds, irrigating moderately during the dry season, and supplying manure where necessary. The only manure I had at command has been vegetable, consisting mainly of the leaves and woody portion of the plant itself, and of tree and vegetable leaves stored up for the purpose with which I mix a considerable amount of wood ashes. With the aid of this only I have kept plants growing in the same spot for upwards of six years; but consequent on the then very crowded state of the ground, the stems were short and very weak. I would, therefore, recommend a thorough removal after four years, the land to be then well ploughed, cleaned and manured."

Transplanting Necessary.

Conf. with paras. 69, 70, 95, 122, 131, 141.

Hoeing and Manuring.

Leaves as Manure.

Conf. with paras. 70, 86, 100.

Overcrowding Weakens the Stems.

152. (9) ***Gathering the Crop.***—" The periods for reaping will vary slightly according to difference of season I find that in this district three good crops can be relied on each year. The first during the latter half of April, the second about the commencement of August, and the third about the end of November. It will be found of much advantage to postpone reaping the second, and particularly the third, as long as the condition of the plants will admit. If the third crop be cut in the middle of November, the weather here during the remainder of that month is not sufficiently cold to keep back the new growth; and should the young shoots appear above ground early in January, the frosts which are usual at that period seriously injure them and lessen the spring crop.

Seasons of Crops.

Conf. with paras. 70, 79, 85-6, 96, 100, 110, 130.

" My own experience indicates that the stems should be gathered so soon as the cuticle shows a clear brown colour for about one-third of the

Stems Ripe when Brown for one-third the Length.

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length. At this stage, if the soil be good and the plant healthy, the stems will be clean from butt to point, the leaves of a rich dark green above, and pearly white below, and the branch buds at the axil of each leaf-stalk just showing. If gathered earlier than this I find the connection of the fibres very weak, and that a considerable portion separates in the operation of scraping the 'peel.' If allowed a further growth, the *axillary branches will have been thrown out which will cause breakages* at every point both in peeling and cleaning."

Buds Just Showing.

Fibre Weak Before this Stage.

153 (10) ***Height of Stems.***—"The average height of stems grown here has been six feet, after cutting off the soft portion at the top. In gathering I supply each coolie with a sharp pruning knife. With this they cut the ripe stems close to the butt; these are removed in bundles by boys to the nearest manure pit. Here the boys cut off nine inches of the top and pass one hand with a gentle pressure from top to butt; this removes every leaf. The stems are then placed in clean water from whence the peelers remove them and separate the peel, which is again thrown into water from which it is withdrawn as wanted by the men who clean it. These lay three or four strips of peel on a flat board, scrape it a few times on the inner side from butt to point, then turn it over and repeat the scraping, which removes the cuticle: it is then hung up or thrown on clean grass to dry."

Top cu off and Leaves Stripped.

Wands Placed in Water. *Conf. with paras. 39, 64, 72, 82, 100, 139.*

Ribbons Scraped.

154. (11) ***Distance Apart.***—"Taking the distance of four feet apart for fully bearing plants, an acre will contain (allowing for paths and water channels) 3,000 plants: more than this I find to be too crowded and to increase labour while lessening the actual yield during a four years' period. Thus planted the yield will be a steadily increasing one, and the plants will not show any deterioration."

3,000 Plants to Acre.

155. (12) ***Yield.***—"From repeated experimental weighings I have deduced the following average proceeds from 1,000 freshly cut six feet stems:—

Yield. *Conf. with paras. 100, 171.*

6·5 per cent. Dry Fibre.

		lb.	
Weight as cut		286	
Do.	when dried	77·5 = 27	per cent.
Do.	fresh peel	83 = 29	"
	dry peel	21·5 = 7·5	"
Do.	fresh wood	203 = 71	"
	dry wood	56 = 19 5	"
Do.	clean dry fibre	18·7 = 6·5	"
Do.	water	208·5 = 73	"

156. (13) ***Influence of Rains on Fibre.***—"If larger stems, from seven to eight feet, be taken the average is less in the weight of peel, but in the outturn of clean fibre it is slightly greater, with small stems from three to four feet. The percentage of peel is markedly greater, but the return of fibre is barely 35 per cent. Moreover, the extra labour in cutting, peeling, and cleaning these small stems is an important consideration.

Percentage of Water. *Conf. with para. 121.*

The crop cut during the rainy season will always contain a larger percentage of water, and that of clean fibre be found rather less, the fibre being also softer than at the other periods of cutting. This I consider due to the fact that at this period the resinous matter in the plant is in a more diluted state, and consequently a greater portion of it is removed during the process of washing and scraping the peel."

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Crop of Rainy Season Softer and less Gum.

157. (14) ***Variation in Quality of Fibre.***—"I have already expressed my opinion against the use of either immature or small stems, as likely to give a result inferior both in quality and quantity; yet I am fully satisfied as to the advisability of not only sorting the crop, as cut, according to length of stem when necessary, but I would further recommend that the peel from all stems of five feet and upwards should be divided into two, and the fibre from the upper and lower portions kept distinct. If cultivated as I suggest, the difference in length of the stems at each cutting will be found very small, the monsoon crop always giving the longest stems."

Quality of Fibre.

Conf with paras. 17, 96, 131, 150.

Stems should be Assorted

Desirable Assort Fibre of Top Half Distinct from Bottom Half of Long Stems.

158. (15) ***Acreage Yield.***—"Taking the above as a basis for calculation, and knowing that each plant established as I recommend will give at least an average of six stems during the first year, I assume:"

Plants × Stems × Crops × lb

$$\frac{3{,}000 \times 6 \times 3 \times 18}{1{,}000} = 972\text{lb per acre per annum."}$$

Yield per Acre.

"In earlier estimates, calculating on closely planted crops and stems four to five feet, I was cautious to restrict my estimate to 750lb per acre, but five years' additional experience has shown me that with proper open cultivation 1,000lb per acre may be fairly assured.

1,000 lb. Fibre per Acre.

159 (16) ***Cost of Production.***—"I would now allude to the cost of growing and separating the fibre into a state fit for export. After a careful review of actual outlay, I estimate this as under:—

Cost of Production.

Conf. with paras. 8, 9, 31, 43, 67, 71, 81, 84, 85, 87, 101, 110.

	R	a.	p.
Land rent per acre per annum	10	0	0
Cultivation ½ man per acre at R5 per mensem	15	0	0
Cutting and training stems, two men for three months at R4 per mensem each . .	24	0	0
Peeling and scraping, seven men at R5 per mensem each	105	0	0
Native supervision at R10 per mensem, for 50 acres, say	2	8	0
Cost of 950lb of fibre	156	8	0
TOTAL .	R369	0	0 per ton,

* This estimate, though doubtless the final results of six years' culti- [illegible] to [illegible] d- [illegible] is

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of which R247-5, or 67 per cent., has accrued in the preparation only of the fibre. This outturn has been obtained under the strictest supervision, and I do not think more could be obtained by native hand labour when doing daily work."

Machinery *versus* Chemicals. *Conf. with paras. 2, 43, 75, 81, 87, 101, 112, 124, 226-8.*

160. (17) ***Separation of Fibre.***—"The best means of reducing the excessive cost of production have been, and are now being, earnestly sought for, and the result is anxiously awaited. Many anticipate that the separation of the fibre may be effected by mechanical means, others that the object may be obtained by chemical processes. Hitherto I think we have been led astray by our knowledge of the Chinese method of preparing the fibre. But, so far as I am informed, the Chinese do not use the fibre in a spun state, but that of divided filaments united into threads by manipulation peculiar to themselves. This process would be equally unsuitable and expensive in Europe as that of the first separation of the fibre has been shown to be.

"We want the fibre in a state in which it can be at once operated upon by machinery and reduced to yarn, and I am deeply impressed by the conviction that this may be accomplished without the aid of any expensive machinery, and of the mechanical power requisite to work it."

Retting a Failure.

161. (18) ***Retting the Fibre.***—"The plan of retting as applied to flax, hemp, sann, jute, etc., is stated to have been in some localities successfully employed with China-grass. I have tried it in every manner at my command on the green and dried stem, as well as on the green and dried peel in running water and in stagnant, both cold and heated. The results have been uniformly unsuccessful. From the peel retted in still water, frequently changed, the fibre was cleanly separated and looked well; but after rinsing and drying was found worthless, being weak, dull and discoloured. In all other attempts the fibre itself decomposed equally with the resinous matter. I may add that I have succeeded in growing and retting flax here which has been valued in England at £6-5-0 per ton, so that my management in retting could not have been so very inaccurate as to have solely caused my failures in these attempts."

Fibre as well as Gum Decomposed.

162. (19) ***Spinning.***—"When proceeding to England in 1871, I took with me from the produce of this estate, dried stems, dried peel and hand-cleaned fibre. All these I succeeded in getting experimented upon by manufacturers who had been accustomed to working the fibre. I may here remark that Dr. Watson refers to the fibre having been worked up by the aid of machinery used for the preparation of flax and wool. Mine was prepared by the machinery used for the utilising waste silk, and China-grass, in the state in which it is usually imported, goes through precisely the same process, stage by stage. The result of these operations

Machinery Employed—that Used for Waste Silk. *Conf. with para. 2.*

showed clearly that both dried stems and peel could be operated upon, each giving a good clean fibre. My cleaned fibre suffered a loss of barely 9 per cent. in preparing it for the operation of the machines Dr. Watson estimates the loss at 25 to 30 per cent. I can fully understand this after examining the specimens of Rhea and Rami I obtained in England. These I doubt not were roughly prepared in the manner described in that gentleman's report (page 37, column 2) where a bunch of the peel is tied by one end to a hook and a scrape on each side of each strip is supposed to finish the work. In this procedure a large amount of evaporation must have taken place before each strip of peel had been operated upon. In my procedure there was no opportunity for evaporation until the clean fibre was exposed to the air; and the repeated scrapings on both sides of the ribband of peel, water being frequently applied during the process, must naturally have removed a much larger portion of the gum and resinous matter than the rude procedure stated."

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Loss of Fibre.

Value of Water during Scraping.

Conf. with paras. 39, 54, 73, 88, 100, 139, 153, 161-2.

163. (20) ***Freight Charges.***—"With the knowledge at present attained it is evident that, however cleanly prepared, the fibre of China-grass has to undergo a manipulatory chemical process prior to machinery acting upon it. This process involves the use of heat, cheap chemicals, and appliances of small cost compared with machinery. I have already endeavoured to show that operating on the plant in its fresh state must be most profitable, inasmuch as under the present system the cost of carriage is reduced to far less than it would be by transport of the produce in any other form not yet known."

Cleaning and Bleaching should be done on the Plantation.

164 (21) ***Advantages of Cleaning Locally.***—"As this chemical process is the first step enforced on the manufacturer, and by it the fibre loses portion of its weight, it would evidently be most desirable that the process should be carried out by the cultivator, or in his immediate vicinity, who would thus save 10 to 30 per cent in cost of transport, besides obtaining a better price for his produce. The results of the experiments made for me in England, showing that clean fibre could be extracted from the *dried peel*, without the aid of machinery, naturally forced upon me the conviction that a similar process would be equally effective on the fresh peel; and as in the latter case the gum and resin would be in a liquid state, they would be far more readily acted upon than after they had been dried and concentrated; therefore that weaker and consequently less expensive solutions would produce the desired effect. I have not had means at my command to procure appliances properly constructed for the purpose, but I have fully satisfied myself of the feasibility of my idea of procedure, and that it will dispense with all costly machinery in the preparation of the fibre in this country unless it be desired to

Gum in Liquid State.

Weaker Chemicals Required.

Conf. with paras. 51, 54, 73, 80.

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convert it into yarn, and then weave it, in which case a factory properly fitted must be established.

Decorticator. Conf. with para. 210.

Hand Decortication Slow.

Outlay on Required Plant.

165. (22) *Mechanical Contrivances for Peeling.*—" Many years back I recollect reading an account of an instrument or small machine which had been invented in America for the use of basket-makers, by the aid of which one man could peel as many osiers in a day as would formerly have employed a score. One or more instruments of this kind, according to the size of the plantation, would meet our first want, as peeling the China grass stems even by an expert hand is a slow process. A properly constructed and fitted boiler in which to subject the peel to the action of the chemicals is the next requirement; and some suitable vessels in which to thoroughly wash the cleared fibre would complete the necessary plant for the factory. The interest on the outlay for these, added to cost of chemicals used, would, I firmly believe, not amount to one-fourth of that of hand labour as at present, and be a small sum compared with the cost of machinery and engine-power to drive it."

Twelve Years' Experiments.

166. (23) " I fear the above expression of my ideas will be considered very startling, and I should not have ventured at present to promulgate them had not this report been asked for by Government. I have now given my opinions, and, with due deference to those of the many clever men whose attention has been devoted to this subject, I believe they will be found worthy of consideration. I have spent twelve years and utterly exhausted my means in the persistent effort to firmly establish China-grass as an important product of this district, and I still trust that some other individual will benefit by my losses and succeed where I have failed from want of means to protract the struggle."

167. (24) " It was my earnest wish to have forwarded a specimen of my fibre prepared in the manner stated, but I have not been able to obtain the necessary materials. Should I do so shortly, a specimen shall be sent."

Suitable Land for Rhea. Conf. with paras 81, 130.

168. *Future Prospects.*—Mr. Montgomery's failure may be attributed to want of funds, to his not possessing machinery and appliance to reduce cost of cleaning fibre and to the low price usually paid for his hand-cleaned filasse. The success that attended his efforts with the cultivation of the plant, would seem to point to a rhea industry being possible in that district and perhaps in some parts of Gurdaspur as well. Much suitable land might be had at reasonable rates, labour could be readily and cheaply procured and possibly river or canal irrigation easily available. But the distance from the seaboard would tell even more seriously on rhea than it

has done on tea. Indeed it may be said rhea would stand a poor chance, remote from the localities where the tea plant is being grown, and within these would have practically to contend with that product for both the capital and enterprise of the Europeans.

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Rhea *versus* Tea.

Conf. with para. 84.

It is nowhere grown by the Natives and is not likely for many years to come to be engrafted on their agriculture. They have other and more convenient crops that give them quite as high a return as ever rhea is likely to do and that too with one-half the labour and with none of the liabilities that rhea contracts would involve. Still it must be admitted that a small farm like Mr. Montgomery's that can to the present day yield stems 8 and 12 feet in height after a continuous production of over 30 years cannot be said to prove the futility of future efforts.

So many persons have endeavoured, yet failed to establish rhea plantations in India that perhaps Mr. and Mrs. Montgomery are no exceptions, but their patience and devotion till death in their self-imposed task, is truly pathetic. They have now passed away and very possibly the future interests in the scene of their labours will be in recording how many years it may be before all trace of the China-grass has vanished from the Ram Bagh.

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169. ***History.***—A volume might easily be compiled from the extensive series of reports, letters, etc., that have appeared in connection with the rhea of these provinces. The plant is nowhere grown by the Natives however and interest centres exclusively in the cultivation of the plant at the Saharanpur Botanic Gardens and in Dehra Dun with a view mainly to supply the material for the two sets of fibre-extracting experiments that were held at the Government Gardens.

Government Rewards.

Conf. with paras. 226-8.

170. In an appendix to this paper I propose to reprint a brief history of the rewards that were twice offered by the Government of India and finally withdrawn. The question is of frequent recurrence as to whether these rewards are still open for competition. It will, therefore, very possibly be a matter of convenience to have full particulars regarding these rewards.

171. ***Reports of Machinery Experiments.***—The reports of the two sets of experiments performed at Saharanpur, have for long

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been in the hands of the public, and I shall not therefore attempt even to review them. But since Colonel H. Hyde's report (*4th October 1872*) on Mr. Greig's Machine contains some particulars regarding the yield of plant and fibre, I may be excused furnishing here the paragraph that deals with these points, the more since the facts brought out are frequently referred to by subsequent writers:—

Colonel Hyde's Calculations. *Conf. with para. 120.*

"The quantity of rhea stems sent to the ground subsequent to the 14th was $3\frac{1}{2}$ tons and was the produce of $1\frac{1}{2}$ acres of land. Of this $3\frac{1}{2}$ tons 480lb of short stems were left unworked as refuse, reducing the worked up stems to 7,360lb or 3·28 tons. The fibre when clean and dry, weighed 207lb, the result being $1\frac{1}{2}$ acres of land produced 7,360lb or 3·28 tons of stalk fit to be worked up by the Exhibitor's Machine, which machine turned out from that amount 207lb of fibre, which gives:—

Yield of Stems and Fibre to the Acre. *Conf. with paras. 34, 71, 79-80, 81, 83, 84, 85, 87, 89, 96, 99-100, 111, 117, 121, 127, 131, 135, 155, 158, 181.*

About . . . . 63 lb per ton.
Or . . . . 138 „ acre."

It will be observed these figures were obtained from one cutting (the chief one), and it is generally admitted two or at most three cuttings may be obtained, but not of equal value These additional cuttings would, however, raise the amount of fibre annually produced to something over 200lb.

172. Sir George King, while Superintendent of the Saharanpur Botanic Gardens, wrote a long and highly instructive paper on the subject of rhea which will be found in the Journal Agri.-Horticultural Society of India, Vol. I. (n s. 1869), pages 400-411. In that paper he remarks, while commenting on the results obtained at Dehra Dun:—

Two or Three Cuttings a Year Usual. *Conf. with paras. 70, 79, 85, 96, 100, 130, 152.*

"I think, however, that if well manured and watered, three crops (as is the case of China) might be obtained. It is in the moist climate of Assam that four or five crops may be obtained in a year." Again in another place he says:—"In estimating the return to the cultivator, the plant being in the ground all the year round, both *rabi* and *kharif* land rent must be debited against the crop, and also water rent where irrigation is necessary. Besides this, allowance must be made for more manure than the native cultivator usually puts on his land. But the amount of labour wanted in an established field would not be great."

Cost of Production.

Unfavourable to Extended Cultivation.

It will thus be seen that Sir George King fully realized the more serious aspects of any definite efforts being made to establish the crop in the North-West Provinces. The reader should consult the paper in the original, and it will be found to review the question of

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yield, cost of production and value of the produce, in other provinces up to the period dealt with, but from want of data affords little additional information regarding the North-West Provinces than is contained in the two passages above.

173. Mr. Gollan, the present Superintendent of the Saharanpur Gardens, is entitled to speak with assurance. He has been intimately connected with all the rhea experiments that have been undertaken in these provinces for many years past At my request he has furnished the report given below, which will be found to confirm, in a striking manner, what I have endeavoured to show while speaking of North Bengal and Assam, *viz.*, that if rhea cannot succeed in its area of present cultivation, it stands a poor chance of succeeding anywhere else in India:—

Saharanpur, dated the 24th July 1896.

174. "With reference to the request contained in your No. $\frac{1115}{75}$, dated the 21st July 1896, I have the honour to furnish you with the following details on the subject of rhea in answer to the questions put by you in the printed circular received with your above-quoted letter.

Rhea Exists.

175. (1) ***Conditions Necessary.***—Rhea will grow, or, to be more precise, exist, in nearly all classes of cultivable soils with a minimum of attention, but in order to make it produce long straight wands of good fibre-yielding quality, it requires a warm humid, equable climate, a rich friable loamy soil, which, if further enriched with liberal dressings of fertilizing manures, such as cow and horse dung, bazar refuse, etc., so much the better.

Three Crops a Year.

Conf. with Paras. 70, 79, 85, 96, 100, 110, 130, 152, 172.

176. (2) ***Number of Cuttings.***—In the Saharanpur district, Rhea yield three crops in the course of a year, but four to five crops of wands of indifferent quality can be forced on by cutting the wands prematurely, *i.e.*, before they are sufficiently ripe for yielding fibre of good quality.

Irrigation Necessary.

177. (3) ***First Crop.***—The first or spring crop begins to sprout early in the hot or dry season, and under frequent irrigation, yields wands from 2½ to 3 feet long. This crop in order to save it from being smothered by the stronger set of wands which spring up after the breaking of the monsoon rains is cut about the middle of June. The outturn of this crop is light, not exceeding 6 to 7 cwt. per acre, weighed after the wands have been stripped of their foliage. Owing to the shortness of the joints and all round shortness of the wands, it can hardly be considered a crop as far as the production of fibre is concerned.

Yield.

The only Good Cutting

178. (4) ***Second Crop.***—The second or monsoon season crop is the chief, and practically only good fibre-producing crop the plant yields in

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the North-West Provinces. This crop is ready for cutting about the middle of September. Up to the time of cutting, the wands give no signs of flowering, therefore ripeness for cutting is not guided by the appearance or non-appearance of flowers, but is known by the colour of the wands. When ready for cutting, these have changed from a pale green to a light brown colour. A good wand when ripe, should be 5 to 7 feet long or longer, flexible throughout its length, of a uniform light brown colour nearly its whole length, and the joints between the leaves of as near even length as possible. Wands fully answering to the above description are never produced here. The maximum length of our wands averages 5 feet, and as they invariably begin to become hard and woody at the lower ends before the required light brown colour has extended to their full length, our wands have to be cut while the upper half is still soft and green, and with the fibre in its upper portion naturally not developed to its full strength. Our chief and only good crop of wands, is, therefore, cut, while the upper half is unripe, to prevent the lower or most productive portion from becoming too hard and woody for the extraction of the fibre.

Length of Wands. *Conf. with paras. 70, 79, 83, 86, 93, 100, 104, 143, 153, 168.*

Unevenly Developed.

179. (5) ***Third Crop.***—"The third or last crop of the season springs up immediately after the rainy season crop has been cut, and continues growing until checked by a succession of cold nights or until killed to the ground by frost. This crop is the only one which blossoms, but as the flowers are invariably blighted by continued cold or by frost, seeds are never formed, so the species or form of Rhea grown here (Bœhmeria nivea or true China-grass) has never been known to ripen its seeds in this climate. The length of wand produced by this third or last crop varies from 1½ to 2½ feet, according as the cold weather begins early or late. After growth has been checked by cold or blighted by frost, the wands, if not cut gradually, wither and die to the ground and the roots lie dormant until the following spring. The outturn of wands varies with the season, but as a rule it is even lighter than the outturn of the spring crop, and, as is the case with the latter, of little account as a fibre-producing crop.

Seeds Never Formed. *Conf. with paras 17, 28, 31, 79, 83, 128, 179.*

Length of Wands.

180. (6) ***Yield.***—"The monsoon season or chief crop is considered good when it yields one ton of green wands per acre weighed after stripping off the leaves. If cutting is done at the right time, *i.e.*, when the wands have coloured up as far as possible without being too woody at the lower ends, the leaves which are stripped off weigh about a fourth more than the wands. A good crop of wands weighed with the leaves therefore averages 2¼ tons per acre.

One ton of Green Stems to the Acre. *Conf. with paras. 34, 71, 79-80, 81, 83, 84, 85, 87, 89, 96, 99-100, 111, 117, 121, 123, 127, 131, 135-6, 153, 168, 171.*

181. (7) ***Percentage of Fibre.***—"The percentage of fibre ribbons to the ton of wands varies with the amount of degumming and cleaning the

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ribbons are subjected to. If the latter are well washed, and most of the gum and outer bark got rid of, 3 to 4 per cent. of clean ribbon * is the average outturn. If the ribbons are simply peeled off the wands and dried together with the adhering gum and bark, 5 to 7 per cent., and perhaps even higher, is the average outturn. I think 4 per cent. may be *taken as high yield of well-cleaned ribbons.*

3 to 4 per cent. Clean Fibre. 5 to 7 per cent. Ribbons.

Conf. with para. 171.

182. (8) ***Propagation.***—" In the absence of seeds, this garden has always depended upon root division for the propagation of Rhea. It can be raised early in the rains by cuttings made from wands produced by the spring crop, and later on in the rains by cuttings made from wands produced *after the rains have begun. Root division is, however, to be pre*ferred as cuttings take nearly two years to form good strong wand-pro*ducing stools,* whilst roots will form firmly strong stools within a year from date of planting. Root division can be done all the year round, though in the cold weather the roots will not sprout until the advent of warm spring weather, but just before or immediately after the monsoon rains begin, is the most preferable season. The process of division is extremely simple. All one has to do is to cut the roots up into pieces 2 to 3 inches long, in dry districts lay the ground out after it has been well manured and thoroughly broken up with the plough, in beds for irrigation, and plant the pieces of root in patches of three or four pieces 3 inches below the surface of the ground, in rows at 18 inches apart and the same distance asunder between the patches in the rows or even a little closer *when roots are available in abundance. It is, however, not advisable to* plant too closely, or it will be difficult in after years to stir and manure the ground between the stools. If the soil is naturally rich and has been well manured before being planted up, no further manuring will be essentially necessary until after the lapse of two seasons, but Rhea being a gross feeder and exhausting crop to land, annual heavy dressing of manure will be necessary after it has occupied the land for two consecutive seasons.

Stem Cuttings. Root Cuttings.

Conf. with paras. 39, 69, 79, 83, 86, 92, 102, 104, 128, 131, 143, 149.

Season of Planting.

Method of Planting.

Subsequent Manuring.

Conf with paras. 70, 79, 83, 86, 91, 96, 100, 127, 131, 141, 151, 172, 175.

183. (9) ***Not Cultivated by the Natives.***—" Rhea is not known *in this district outside of the Botanical Gardens, therefore it possesses no* local or vernacular name.

184. (10) ***Cost of Production and Price of Produce.***—" I do not look upon Rhea as a crop that can be grown with profit in the

Crop not Recommended for Upper India.

* It is not quite clear whether "cleaned ribbons" should be read "cleaned fibre." The estimate of 1 ton green stems appears to be the chief crop only: the other two crops very possibly might add another ton or, at 4 per cent. cleaned fibre, a total yield of 179lb per acre per annum.—*G. Watt.*

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Price.

Conf. with paras 3, 4, 34, 43, 65, 71, 81, 83, 84, 103, 114, 124, 126, 136, 140, 142, 186.

Railway Charges.

North-West Provinces, or anywhere in Upper India, at the price I understand from an article lately published in *The Pioneer*, as at present being offered at Bombay for the ribbons. In that article, mention is made of the low figure of £7 per ton as the present price of ribbons delivered at Bombay (*see paras. 126, 188 (8)*). Taking Saharanpur as a centre for calculation, freight alone upon a ton of unpressed Rhea bales amounts to R75-4-0, which converted into sterling at one shilling and two pence per rupee, amounts to £4-7-9½, leaving a balance of £2-12-2½ per ton for the grower to meet cost of cultivation, cost of stripping the ribbons from the wands, and cost of drying, packing and delivery at the railway station, etc. In the comparatively dry climate of Upper India, the cost of cultivation is very high, as the absence of atmospheric humidity and equable tropical warmth at certain seasons of the year has to be compensated for, in order to secure which at the best is only a light crop, by choosing the richest of soils further enriched with expensive dressings of fertilizing manures and frequent stirrings of the soil between the plants.

Dehra Dun.

185. (11) ***Kangra and Dehra Dun.***—" Saharanpur is certainly not a good spot for Rhea cultivation, but it is typical of large stretches of country in Upper India. I will admit that there are a few favoured spots in Upper India where Rhea thrives better and may cost a little less for cultivation than it does here; Dehra Dun and the Kangra Valley for instance, but even in such districts its cultivation cannot possibly pay at the price quoted.

Price Paid Requires to be Tripled or Quadrupled.

186. (12) ***Rhea*** versus ***Tea***—" Both these districts are a considerable distance from the line of rail, so after meeting the extra charges caused by road transport, cost of production would be on much the same level as at Saharanpur and other places near the railway. If the quoted price were tripled or quadrupled, it might be worth while for planters at Dehra Dun and in the Kangra Valley to try experiments with Rhea cultivation, but even at a quadrupled rate (£28 per ton) the growers' profits would not, in my opinion, be at all extravagant.

Ribbons at £28 a ton Would not be Extravagant.

" I may remark in passing, that the two districts I have named are tea-growing districts, and that I look upon tea cultivation as good objective to hold in view when looking for likely spots for the, perhaps, eventual profitable cultivation of Rhea. Where tea thrives, I believe Rhea will thrive, and also that it will cost less for cultivation than in districts of which Saharanpur may be taken as the type. Moreover, where tea gives the best results, Rhea will, I have no doubt, be found to give the best results. Dehra Dun and the Kangra Valley are not to be compared with some parts of Assam and Ceylon as paying tea-producing districts, and I am firmly of opinion, neither will they compare with the latter districts as paying rhea-producing centres.

Succeeds Best where Tea Grows

Conf. with paras. 84, 101.

SAHARANPUR EXPERIMENTS.

187. (13) "*To sum up in conclusion, rhea, as I have already indicated, will grow or exist with little care in the most indifferent of soils almost anywhere in India. If the price procurable for the ribbons should in the near future rise sufficiently high to encourage speculation in its cultivation, I believe districts favoured with naturally rich soils and warm equable climates will in the long run entirely oust the most favoured Upper Indian districts in its cultivation. I, therefore, take this opportunity of warning the Upper Indian planter, to make sure of his ground by experiments on a small scale, before he largely sinks his capital in Rhea cultivation.*"

Rhea Will Exist Anywhere

188. ***Other Provinces of India.***—It is perhaps hardly necessary for me to add that the entire volume of available evidence most fully supports Mr Gollan in every opinion, which, after years of practical experience, he has formed. There is nothing to show that rhea can be grown commercially anywhere in the vast plains of the North-West Provinces and Oudh, nor in the Central Provinces, nor in Bombay. Here and there within each of these provinces there are of course sub-montane tracts where some degree of success might be obtained, but experience in South India can hardly be said to justify even these being at present selected for experimental cultivation on a large scale.

Unsuited to these Provinces.

CONCLUSION.

189. Under paragraphs 60-75. I have given a summary of some of the leading facts brought out by the study of the rhea industry of Bengal. It may be useful to exhibit here the final conclusions:—

(1) Rhea is not indigenous to India

(2) It is fairly extensively grown by the inhabitants of a few of the districts of North Bengal, throughout the greater part of Assam, and in Upper Burma. But it is nowhere else raised as a fibre crop by the people of India.

Indian Area of Present Production.

(3) While the plant may be grown as a garden curiosity almost anywhere in India, the experiments to establish production on a commercial basis have hitherto been attended with scant success, and mainly because they were performed in localities that it might have been foreseen could give little prospect of success.

Chief Experiments Performed in least likely Localities.

(4) It seems fairly conclusively shown that the future endeavours to establish rhea as a commercial product will have to be restricted to the localities indicated, namely, the districts where for centuries very possibly it has been grown by the people as a

BŒHMERIA nivea. | Conclusions.

CONCLUSION.

regular crop. These have been spoken of collectively (in the foregoing remarks) as a sub-montane tract that lies between 25°—30' and 28° north latitude. If to this be added the Kangra district, the Indian area of successful cultivation is carried to the 32° north latitude. In other words the most southern extremity (Rungpur and Bogra) is approximately in the latitude of Canton and a portion of Formosa and the most northern point (Kangra) is in the latitude of Nanking. Thus the Indian region indicated corresponds fairly closely in point of latitude to the more important Chinese area of production.

Correspondence to the Rhea Area of China.
Conf. with para. 66.

Reductions in Cost of Production.

(5) It is of necessity an expensive crop, for it occupies the soil for several years, requires much manure and careful protection from animals. The fibre is difficult to separate, and clean, and hence a cheap and effectual machine or process is as much a desideratum now as it ever has been. Unless great reductions can be effected in fibre extraction, India does not seem likely to be able to produce clean fibre at less than eight annas a pound or, say, £72 a ton, exchange being *1s.* and *4d.* to the rupee. By hand labour the cost of separation and cleaning comes to between 50 and 60 per cent. of the total cost of production.

Cost of Hand Cleaning.

Has to Compete with Tobacco and Ginger.

(6) In the agricultural systems of the Bengal region of present production, it has to compete with tobacco and ginger. Unless, therefore, it will pay as well if not better than these crops, an extended production on the part of the Native cultivators cannot be looked for. It does not compete with rice and jute, since it commands the high lands and rich loamy soils.

Has to Compete with Tea.
Conf. with paras. 81, 101, 186.

In Assam it has to compete with tea and will require, therefore, to give reasonable prospects of a good margin of profit, before it can ever succeed in diverting European capital and enterprise from one of the most securely established of Indian industries.

Available Land in Bengal.

Assam has the best Climate.

Prospects of Burma.

(7) In Rungpur it would very possibly be extremely difficult to obtain suitable soil at reasonable rates. In Jalpaiguri and the Duars much good rhea land is no doubt available, and in these districts the labour question would very possibly be much less serious than in Assam, though the climate of Upper Assam would seem by far that best suited to the plant. The backwardness of Burma, especially within the Shan States, where alone this plant seems to be regularly grown, will very possibly stand in the way of that country being taken into immediate consideration by intending planters. Outside the districts of existing

CONCLUSION.

cultivation Kangra would seem, in point of locality and climate, the most hopeful. Rhea has been shown to give in Kangra a very much higher yield than in the districts of South India where fairly extended experiments have been conducted.

Prospects of Kangra.

Prospects of South India.

(8) Lastly, until a few hundred acres of land in Rungpur, in the Duars, in Sibsagar, in Lakhimpur, in Upper Burma, and in Kangra have been systematically cultivated for a term of years, we shall not possess the data upon which to decide whether or not rhea production can be made profitable in India. But I feel constrained, after a fairly careful examination of every aspect of the question, to affirm that under no circumstance can ribbons be produced in India at the figure recently demanded, namely, £7-10 per ton. Until, therefore, the great merits of the fibre are recognised and much higher prices offered than at present, it is quite useless to look to India as country of supply.

Further Experiments Essential.

At Low Prices India Cannot Compete.

III.—Villebrunea integrifolia, *Gaudich., Bot Bonite Voy. t. 91; Fl. Br. Ind., V., 589;* URTICACEÆ.

BON OR BAN RÍHA: WILD RHEA.

190. *Syn.—Blume Mus. Bot., II., 166;* URTICA ACUMINATA, *Roxb. Fl. Ind., III., 592;* VILLEBRUNEA APPENDICULATA, *Wedd. in DC. Prod, XVI, 1., 235,* OREOCNIDE ACUMINATA, *Kurz. For. Fl. Burm., II., 427;* URTICA APPENDICULATA, *Wall. Cat. No. 4604;* CELTIS ELONGATA *and* C. TETRANDRA, *Wall Cat. Nos. 3692 C. and 3692 F.*

191. *Vern Names.—Ban (bon-riha)* (wild rhea) is the name for the fibre, the plant being *Bon kotkora;* the (true *kotkora* is Vangueria spinosa) Ass; *Ritza* (or for brief *Ree*) Jabaka Naga; *Jutta*, Naga; *Lookoy*, Singpho; *Lipic*, Paharia; *Kaphutki*, Lepcha.

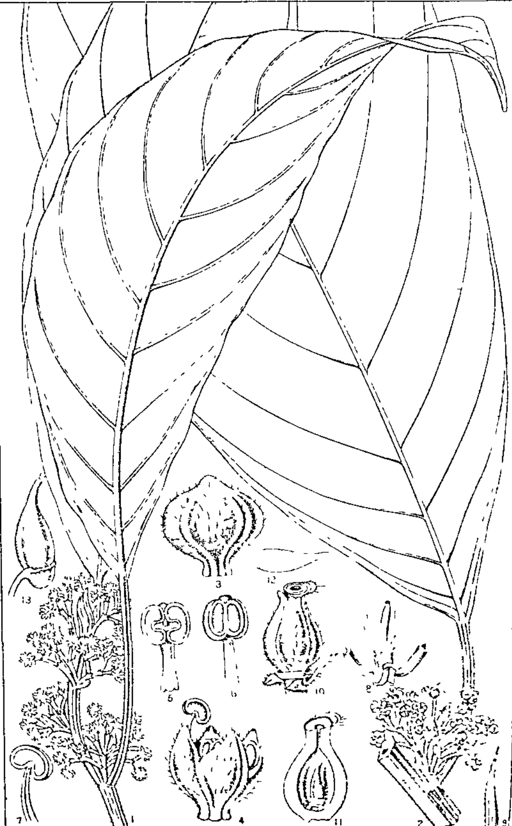
192. *References.—Robinson, Assam (1841), 67; Thomson, Jour., Agri.-Hort. Soc. Ind., Vol. VI. (1848), 184, Hannay l. c., Vol. VII. (1850), 222-23; Royle l. c. Ix., (1857), Selections p. 230, also in Fibrous Plants, pp. 355-56, Watson, Report on Rheea Fibre (1875), p. 1; Gamble, Trees, Shrubs, etc., Darjeeling, p. 77, also Man. Timb., p. 325; Watt. Sel. Rec. Govt of India, Vol. I., p. 315, Cross, Bevan and King, Report of Indian Fibres, p. 34; Talbot, Trees, Shrubs, etc., Bombay, p. 197.*

Distribution of the Plant.

193 *Habitat.*—Met with plentifully at the foot of the Eastern Himálaya from Sikkim to Nepal; throughout the valley of Assam, especially near the foot of the hills, and distributed within the Assam hills from the extreme north through the Naga country to the Khasia and Garo Hills, thence to Manipur, Cachar, Sylhet and Chittagong; also the mountainous tracts of Burma (as far as Tenasserim) and to the Yunan Province of China. So again it occurs in the damp valleys of the higher Konkan Ghats and is distributed to the Andaman Islands

It frequents damp glades near streams but with its roots above water level and is often so extensively pollarded that it resembles in some respects a large leaved willow. While passing through the Nambar Forest I heard of a place known as *Ríha-kata-jan* that was famous because being the head-quarters of the Mikir collection and preparation of *ban-ríha* fibre

194. *Citation of Collections and Authors.*—In the Royal Botanic Gardens' Herbarium there is a very extensive series of speci-


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mens by Jenkins who sent it from Gauhati with a note on the label "This is the *Ban Rheea* from which China-grass cloth fibres are prepared" Wallich, Nos 4604 and 3692 from Sylhet; Griffith No 4577 from East Bengal; Hooker & Thomson from the Khasia Hills; Masters from the Naga Hills; Mann from the Duffla Hills; Kurz & King from Sikkim, and Gibson from Western India, etc, etc.

Standard Collections.

It has thus been fully recognised by botanists and has not infrequently been mentioned as the plant that afforded the *ban-ríha* fibre, but in no instance is it stated as being cultivated It is purely an indigenous plant, but because of its being called *ban* (wild) *ríha* arose the very mistaken notion by writers who had very possibly never seen it that it was the wild plant from which by cultivation the rhea had been developed, and the still more pernicious error that, seeing that rhea was thus wild in India, the fibre could be procured for little more than the cost of collection. As fully illustrative of this error I may give the following passage from Dr. Forbes Watson's Report. While speaking of the history of rhea he says, "The matter then dropped until about 1840 when attention was again directed to it by Colonel Jenkins, who discovered the *same plant growing wild in Assam* and transmitted a few specimens to the Agri.-Horticultural Society of Calcutta." Now neither Jenkins, Hannay nor Dalton ever say they found B. nivea wild, but are most careful to mention that the *Ban-ríha* (or so-called wild *ríha*) plant is perfectly distinct from the cultivated *ríha* The nearest approach to making this mistake is the record on a label of one of Jenkins' plants already quoted, but even he nowhere makes that statement in any of his letters or reports.

Pernicious Error. *Conf with paras 5-7, 77, 117.*

Early Investigators Never Mention it as Wild.

Wild Ríha. *Conf. with paras. 6, 7, 41, 42, 44, 52, 60, 76, 77, 83, 128, 197.*

In this connection it may be added that, although the plant is found in the Konkan, the people of Western India do not appear to have discovered its great textile merits. At all events none of the European writers on the botany or economics of Bombay Presidency so far as I have been able to discover, allude to the fibre

195. ***Description.***—A small ever-green tree or large bush, which, when pollarded, produces many erect straight branches, 5, 10 or 15 feet in length. *Leaves* 6-14 inches long, elliptic oblong, caudate entire or when young obscurely crenate, penninerved (8 15 pairs), membranous and tomentose, the leaves of staminate plants much more velvety than of the pistilate; *petiole* 1 to 6 inches long; *stipules*

silky villous. *Flowers* very minute, the males (staminate flowers) on one plant and the females on another; clustered on small dichotomously branched cymes, that are situate on the lower portions of the branches below the leaves or around the scars of fallen leaves; male clusters considerably longer stalked and more open than the female; male flowers 3-4 merous, the perianth adnate to the ovary and to the achenes.

Plate III.

196. Plate No. III represents this plant. It was obligingly furnished me by Dr. Prain and is a reduction and adaption of Gaudichaud's table 91, the original representation of the spices. Dr. Prain has furnished the following descriptive note regarding the plate *:—

197. ***History of the Fibre.***—Colonel Hannay was the first writer who drew definite attention to this fibre; he did so in his paper *"On the Rheeas and Nettle Grasses of Assam."*

Is a Forest *Tree.*

"This is a jungle plant, he says, common in most of our forests, thriving best in the vicinity of water or running streams. When unmolested it grows to a tree, but, by proper management, any quantity of young shoots can be obtained, and as the divided roots afford numerous shoots, and the plant can be propagated by slips as well as by the seed, its cultivation for its fibre might be carried on, the same manner as practised in Europe with the willow. I have shewn the leaves of this plant to the Chinese here, who say the fibre is exported into Southern from Northern China. It is cultivated largely by the hill tribes on the North-West of Yunan and by the Singhpoos and Dhoanneas of our own North-East Frontier to a small extent only, for a coarse cloth but chiefly for nets. *It* is recognised by the Nepalese as *Leepeaah.* Samples of this fibre have been most favourably reported on by Captain A. Thomson (see Journ. Agri-Hort. Soc, Vol. VI., p. 184)."

Reported to be Used in China.

Said to be Cultivated in Yunan.

Made into Cloth.

Captain Thomson's Report.

Captain Thomson's report was to the effect that the fibre was all that could be desired for either canvas or lines and only required to be known to be generally used for these purposes. Samples of

* [illegible]

5, 6, 7. Stamens at various stages.
8. Pistil, abortive, surrounded by 4 filaments.
9. Bract.
10. Female flower.
11. *Pistil in vertical section the perianth removed.*
12. Stigmatic hair enlarged.
13. Ovule.

this wild rhea fibre appear to have been sent home from Major Hannay's collection, and Royle informs us that he had submitted these to the Society of Arts (*Journ. 9th December 1853, pp. 60-61*)

Is Inferred to be Wild Rhea.

In a paper which will be found in the *Journ. Agri.-Hort. Soc. of Ind. Selections to Vol. IX. (1857), p. 23*, Royle says of the *bon-rhea* :—

"No information is given respecting the plant yielding it, but it is no doubt one of the nettle tribe, and from being called *bon* or jungle *rheea*, it has been inferred that it may be the *rheea* in a wild state. But though we have no proof of this, it is satisfactory to find that Major Hannay describes it as 'uncultivated, but very common in all parts of the province' and again 'common in most of our forests'"

Is Stated to be Wild.

198. ***Comparative Strength of Ban-rlha Fibre.***—Royle then furnishes the following table to show the results of the comparative tests that had been performed with several Indian fibres including Major Hannay's cultivated Assam rhea and his *bon-rhea* :—

Comparative Strength.

	℔
"Petersburgh clean Hemp	160
Jubbulpore Hemp	190
China-grass	250
Rheea Fibre	320
Wild Rheea	340"

Stronger Than Rlha.

It will thus be seen that, according to these figures, the *ban-rlha* was proved to be stronger than the China-grass (presumably from China) and the rhea (presumably from Assam).

In another part of his paper Royle furnishes the results that had been obtained by Messsrs. Huddart & Co. from their Rope Manufactory Limehouse, on the 13th February 1854 —

Report on Experiments on Strength of Rope made from samples of Rheea and Bon-rheea Fibres from Assam, received from the East India House

DESCRIPTION.	Size of rope	No. of yarns per strand.	Total number of yarns in rope.	Strength of rope in ℔.	Strength of rope per inch of circumference squared.	Size of rope at breaking.	Tar absorbed.	Amount of stretching.
Wild Rheea, 1st experiment .	4	$44\frac{7}{8}$	132	19,032	844*	$4\frac{3}{8}$	1—7th	1 in 16
Wild Rheea, 2nd experiment .	4	$44\frac{7}{8}$	132	20,124	894*	$4\frac{3}{8}$	1—7th	1 in 16
Rheea Fibre .	4	$44\frac{7}{8}$	132	20,488	910*	$4\frac{3}{8}$	1—9th	1 in 16

* The average strength of rope made with the best hemp and after numerous experiments from 1803 to 1808 is 805.

VILLEBRUNEA integrifolia.

Ban Riha.

Present Knowledge.

199. It will thus be seen that the *ban-rhia* fibre was found to be quite as strong as the true rhea of commerce. It is an extremely abundant plant, occurs in all the damp valleys of Assam, is highly valued by the hill tribes, by some of them even preferred to the true rhea, and yet we know no more about it in European commerce to-day than was made known to the world half a century ago, through the combined labours of Major Hannay, the Agri.-Horticultural Society of India, and Dr. J. Forbes Royle

Previous Reports.

Present Investigations.

I have already given in the Dictionary and elsewhere a fairly complete statement of available information compiled from the standard books that deal with Indian Economic Products. These articles can be consulted, therefore, by readers who may desire a sketch of the earlier opinions. It very possibly, however, may be more useful to planters and others, who contemplate opening out experimental plots of this plant, if I give a brief abstract of my personal investigations and of the opinions of those whom I have consulted. I shall give here accordingly a selection from the letters and communications received from practical men whose co-operation I have been fortunate enough to secure.

200. ***Chemical Examination of the Fibre.***—The sample of this fibre sent to the Colonial and Indian Exhibition having been viewed as doubtfully correctly named, it was not examined by Messrs. Cross, Bevan & King, and accordingly not reported on in their Indian Fibres and Fibrous Substances shown at the Indian Section of that Exhibition. These authors accordingly only make a very brief and somewhat unfavourable allusion to the fibre. In Spons' *Encyclopædia* it is said that "the fibre is more easily separated than that of the preceding (rhea) and is considered one of the strongest in India."

Found in the Plains of Assam.

Mr. J. Melrose Arnot's Report.

Some short time ago I invited Mr. J. Melrose Arnot, Chemist to the Bally Paper Mills, to examine and report on a small sample of the ribbons of barks which had been roughly stripped by myself from a few branches cut from a plant found on the sloping banks of the Rajghur Ali (an elevated road) near Lackwah, Sibsagar.

Experiment, Botanical.

I would explain that these ribbons were not scraped nor put through any preparation. My object was in fact to secure the entire ribbon of bark, fibre, and gum, simply dried in the shade. It seemed to me desirable to discover the loss in purification and the degree of resistance, if any, which the gum might make against a mild chemical

Ban-Rîha. (G. Watt.) VILLEBRUNEA integrifolia.

treatment. The plant had been carefully identified by me; the corresponding botanical specimens to the barks were registered as No. 12258 and were collected on the 7th March 1897. It was a male tree in full flower. The tree had not been systematically pollarded and the shoots were old and fully ten feet long and an inch or more in thickness at the bottom. The season of the year was, moreover, my Assamese informants said, not the correct one. The shoots then on the tree should have been cut off and rejected, and the young shoots that would be found on it in June to October alone collected for fibre purposes.

Condition of Plant from which Derived.

Not the Correct Season.

It is necessary in considering Mr. J. Melrose Arnot's report that follows, to bear these unfavourable facts in mind. Mr. Arnot writes :—

"The following figures are the results of the chemical investigation :—

Moisture.	Cellulose.	Mercerisation.	Nitration.
11·45	26·01	16·40	129·29

Chemical Results.

The fibres are beautifully white and of a fine silky lustre, measuring 25 to 30 mm. long and 0·013 mm. in diameter; they are cylindrical or nearly so with a slightly striated exterior thick walls and small central canal; ends tapered. A pecto-cellulose very similar to flax but much finer while being equally long.

Length and Thickness of Ultimate Fibres.

Finer than Flax.

"I have endeavoured to make this report in such a way that the results may be strictly comparable with those obtained by Messrs. Cross & Bevan for so many other fibres, but inasmuch as their reports are mostly based on examinations of the hand or machine-cleaned textile fibres, an entirely satisfactory comparison cannot be obtained. I regret also that owing to an explosion of nitro-cellulose in my laboratory one series of experiments was entirely destroyed, but the figures here quoted are the mean of two series.

"I have been unable to obtain a sufficient quantity of fibre of full length (textile filaments) for the purpose of making a strength test to compare with the tests of other fibres made by Mr. Geo. Ashton.

Strength Test.

"I have been expecting a fresh supply of the bark from you, but it has not as yet come to hand; I trust, however, that this may prove useful, and when you can supply a quantity of hand-cleaned fibre I would be glad to make a more extended examination.

Clean Fibre.

"As compared with the fibre of Bœhmeria nivea this is exceedingly fine, indeed it is one of the finest fibres I have ever measured—and, although not anything like so fine in the individual fibre, the filaments are long and

More Easily Workable.

strong, and I have no doubt that in every respect the material would prove more easily workable on textile machinery, and it would undoubtedly produce very much finer textures than Bœhmeria nivea.

Perfect Substitute for Linen.

"I have not seen the fibre of Bœhmeria tenacissima, but, from descriptions I have seen, this fibre seems to resemble it very strongly and ought to be the most perfect substitute for linen.

Colouring Matter.

"The colouring matter contained in the bark appears to be very well worth serious study."

I was unfortunately unable to furnish Mr. Arnot with hand-cleaned fibre for some time subsequent to the receipt of the above report, and when procured by me Mr. Arnot was unable to afford the time to prosecute his investigations. The low percentage of cellulose must be very largely accepted as due to the nature of the sample examined.

201. ***Yield of Fibre to Green Stem.***—Mr. L. A. M. Lumsden of Nahor Rani Tea Company, Tezpur, at my suggestion has gone into the question of an experimental cultivation of this plant. He has furnished me with a large supply of ribbons cut from wild plants and I trust very shortly, through the Research Department of the Imperial Institute, to be able to furnish a fuller report both as to the chemical and structural peculiarities of the fibre, and its value as a textile. Meantime I may mention the following particulars that have been furnished by Mr. Lumsden :—

Yield of Fibre

"Weight of green branches . . . . . . 36 mds. 32 seers.
Weight of green ribbons . . . . . . 3 ,, 30 ,,
Weight of dry ribbons . . . . . . 1 md. 30 ,,

These figures may, therefore, be accepted as indicating the yield of dry fibre to the weight of green shoots which the plant affords.

Various Plants Called Ban-Riha.

202. ***Different Plants Spoken of as Bon-riha.***—On my arrival in Assam I made enquiry for the plant known as *bon-riha*. I was on several occasions shown Urena lobata as being the *bon-riha*, and Mr. Whigham sent me from Golaghat Triumfetta rhomboidea under that name, though he subsequently gave *son-borial* as the correct vernacular for that plant. On one occasion, while in Sibsagar district, I was told that the *bon-riha* was being cultivated at a certain village. I took an opportunity to visit the village and found, much to my astonishment, a small field of Urena lobata. Both the above-mentioned plants are well known to afford valuable fibres. Mr Cowling, of Chittagong for example, informs me that the Urena is there known as *sesh* (white) *lehra* and the Triumfetta as *kali* (black) *lehra*. Though the former belongs to MALVACEÆ and the

Urena lobata.

Triumfetta rhomboidea.

Chittagong Fibres.

latter to TILIACEÆ they are no doubt from the Native standpoint nearly related plants. Mr. W. Leeds, Conservator of Forests in Assam, wrote in 1870 that the *bon-ríha* was a species of **Urena** — " A common tropical weed of the order MALVACEÆ and not related to the true rhea. The fibre of **Urena** is used for the manufacture of rope and is much inferior to that of **Bœhmeria**." It will thus be seen that the error of confusing these jute-like fibres with the *bon-ríha* has prevailed for some time in Assam.

Nagas remonstrate Separation of the Fibre.

203. ***Further Particulars Regarding the True Bon-riha.***— Mr. John Phillips, of Suffry, Sibsagar, was good enough to interest himself in my enquiries regarding the *bon-ríha*. He not only succeeded in discovering the plant in a glade behind his bungalow, but in securing some Nagas to show me their method of cleaning the fibre In one of his letters, written subsequent to the date of my visit to Suffry (29th November 1897), Mr. Phillips furnishes useful particulars regarding the name of the plant:—

Name of Fibre.

"I take the name *bon-ríha*, he says, to be applicable to the fibre and not to the plant from which it is obtained. The plant is called *bon-kotkora*, but whether this is Ahom or Hinduised Assamese I cannot tell, nor can I say why it is called wild *kotkora* The Singpho Doanneas call the plant *lookoy khoon*, the latter word meaning plant or tree. The Nagas in this neighbourhood call the plant *Jutta*

"I showed the plant yesterday to Mr Monahan, and he said it was quite different to the plant shown to him as *bon-ríha* in Lower Assam which was a decided nettle but different from Bœhmeria nivea. He said that you would not accept it as B. tenacissima."

Bœhmeria platyphylla.

The **Bœhmeria** to which Mr. Phillips alludes is **B. platyphylla**, which not only in Assam but in Bengal is often called wild rhea by the cultivators. But the distinction Mr. Phillips makes in the name *bon-ríha* being applicable to the fibre and not the plant, is worthy of careful consideration. It would seem to support the idea already advanced by me that the word *ríha* may be but of comparative recent adaptation to the fibre of **Bœhmeria nivea.**

Derivation. *Conf with para. 14.*

204. ***Report from the Garo Hills.***—Mr. F E. B. Lloyd, Officiating Deputy Conservator of Forests, has also given attention to the question of the *bon-ríha* plant. In one of his letters he says:—

"I have studied the habits of this tree during the cold weather, and the following facts may be of interest to you. The tree when left unmolested attains a girth of about 2 feet and a height of from 30 to 40 feet. In

VILLEBRUNEA integrifolia. Mr. Severin's Report.

JABAKA NAGAS.

Khasia and Garo Hills.

this district it is found on the hills only, bordering on the Khasia and Garo Hills, but extends all along the southern boundary and is very fairly common. It is only found in mixed evergreen forests and is not gregarious. It thrives principally in shady damp places on the sides of streams, it does not grow at all on the plains or in places exposed to the sun. The tree flowers in March and the seeds ripen in April.

Pollarded.

205. ***Season of Collection.***—The method of obtaining the branches which yield the fibre is to pollard the tree during the months of November to February, when the young pollarded shoots will be available in June and throughout the rains. The fibre is extracted from the branches in exactly the same manner as from Bœhmeria nivea, only the fibre is longer. One man preparing *bon-rīha* can get as much fibre in the same time as three men preparing the cultivated fibre.

Time Necessary to Clean Fibre.

Fibre Used to Mix with Silk.

206. ***Uses of the Fibre.***—"The fibre is only prepared in small quantities and for home consumption. The people use it in making nets and in certain cases for mixing with silk in making cloth. It can sometimes be bought at the village *hats* (markets) where the Garos who principally bring down the fibre sell it at R1 per seer."

Price R1 per seer.

Jabaka Manufactures.

Mr. Phillips was able to secure for me a set of the Jabaka Naga shoulder bags which they weave from this fibre. It is specially selected for this purpose because of the great strength of the textile. These bags are somewhat coarsely woven, but often very neatly embroidered and the Nagas informed me that the *bon-rīha* fibre takes dye very rapidly. Occasionally the shoulder bags are woven half with cotton and half with *bon-rīha*.

Mixed with Cotton.

Fishing Lines of Mixed Rhea and Bon-riha.

Mr. Phillips further informed me that rhea fibre did not in his opinion make a good fishing line since when thrown from the rod it was apt to get knotted, but if mixed with *bon-rīha* this did not occur. This property, if confirmed by future investigations, should prove a great additional merit to the *bon-rīha* over the rhea fibre of commerce.

207. ***A Visit to the Jabaka Nagas.***—But I cannot conclude this account of the information acquired during my brief investigations in Assam without acknowledging the invaluable assistance rendered me by Mr. T. F. Severin, formerly of Tiok, now of Tingali Bam Sanari. Mr. Severin from having to largely employ Naga labour has been brought into constant association with the Jabakas and other Nagas. He has acquired a knowledge of their language and is permitted to visit their country whenever he pleases.

Jabaka Nagas.

Mr. Severin very kindly therefore undertook to accompany me on a short run into the Jabaka Naga country with the object mainly

of collecting information regarding this fibre. We found that they cultivated the rhea (**Bœhmeria nivea**) to a small extent and sold the fibre to the people of the plains. Within recent years, the ease with which they have been able to purchase coarse cotton yarns, has disorganised their indigenous textile industries. They bring down heavy loads of **Arum** (yams) and of the soap nut (**Sapindus Mukorossi**) and barter these and other natural products of their country for cotton yarn and other produce of the plains. Formerly both the fibre of **Girardinia heterophylla** (which they call *tukak*) and that of **Villebrunea integrifolia** (called *ritsa*) were very extensively used, but at the present day the latter is mainly employed for the warp only of the narrow strips of cloth which are made into shoulder bags. It is understood to give great strength to the bags and is thus rarely entirely omitted.

JABAKA NAGA.

Cultivate Rhea.

Exports from Their Country.

208. On the ascent to the Jabaka village, where the head of the clan (or Rajah) lives, we were shown the *ban-riha* plant and the crude method pursued in cleaning the fibre. Mr. Severin has since the date of our visit continued his enquiries, and it will more fully meet the case if I publish here some passages from his highly instructive correspondence, rather than to attempt to describe what I personally witnessed on the occasion mentioned.

Operation of Cleaning Fibre Witnessed.

"I hope you have received," writes Mr. Severin, "the three bags of *ban-riha* fibre or ribbons I sent to you *viâ* Goalundo by steamer and rail. I should say the three bags weighed about one maund."

"I have had very little time to make progress with the plant myself, but of course now from May it will begin giving out its light green shoots which alone are used for the extraction of the fibre."

"*Bon-riha* as the Assamese call it, means of course wild riha, but the Nagas call the same plant *ritsa* or *ree* for short. It is very plentiful round here and near the foot of the hills where it gets a loose soil and plenty of water.

Vernacular of Plant.

209. ***Preparation of Ribbons.***—"The Naga way of producing the ribbons is quite different from the Assamese. The cuttings are best made from May to October—during the rainy season. The quality of fibre depends on the age of the shoots. In old shoots the fibre is less abundant, is not so strong as is largely intermixed with hard woody or lignified tissue. The younger the shoots therefore, the better will be the quality of the fibre.

Young Shoots Yield Best Fibre.

"After cutting, the shoots are carried to the villages where the outside green skin or bark and a little slimy matter is scraped off. Then

Bark and Gum Scraped off.

VILLEBRUNEA integrifolia. — Mr. Severin's Report.

JABAKA NAGAS.

Khasia and Garo Hills.

this district it is found on the hills only, bordering on the Khasia and Garo Hills, but extends all along the southern boundary and is very fairly common. It is only found in mixed evergreen forests and is not gregarious. It thrives principally in shady damp places on the sides of streams, it does not grow at all on the plains or in places exposed to the sun. The tree flowers in March and the seeds ripen in April.

Pollarded.

205. ***Season of Collection.***—The method of obtaining the branches which yield the fibre is to pollard the tree during the months of November to February, when the young pollarded shoots will be available in June and throughout the rains. The fibre is extracted from the branches in exactly the same manner as from Bœhmeria nivea, only the fibre is longer.

Time Necessary to Clean Fibre.

One man preparing *bon-riha* can get as much fibre in the same time as three men preparing the cultivated fibre.

Fibre Used to Mix with Silk.

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Bark and Gum Scraped off.

VILLEBRUNEA integrifolia. | Mr. Severin's Report.

JABAKA NAGAS.

Inner Face of Bands of Fibre also Scraped.

Left to Dry in the Shade

Steeped in Water and Wood-ashes.

Boiled in Rice-Water.

Hand-picked.

Hard-twisted Yarns.

the ribbons of partially cleaned fibre are stripped off the shoots. The inside of these stripes of fibre is then scraped with the knife so placed in the hand as to allow the edge to rest against the fore-finger. The stripes are then drawn through repeatedly in order to remove the slimy and gummy substances from the inner face of the ribbons. After being as well cleaned as possible in this way the ribbons of fibre are left to dry *in the shade* After being fully dried the ribbons next are steeped in water and wood-ashes for about 24 hours and then boiled in rice-water for 4 hours.* The fibre will then be found to be quite free from gum and may be separated into fine threads. This is, however, a tedious process and is mostly carried on by the old people of the villages.

"The thread (yarn) I send you a small sample of, is ready to be woven into cloth. The Nagas believe that the harder the thread is spun the stronger it becomes.

Assamese Method.

Ribbons Twisted into Rope.

"The Assamese take off the ribbons when the shoots are in a half dry state and do not first scrape off the outer bark and gum. They also leave the inner face coated with the slimy gum. They purify it in a coarse way by washing in lime and then twist it into twine or simply divide up the ribbons and, without any preparation, twist these into twine to be used for making nets to catch deer in. The Assamese do not spin or weave it, and I do not think they even make fishing lines and nets from it, but for these purposes prefer the silver-leafed *riha*.

"*Bon-riha* will not grow where water stands. You recollect seeing it on the embankment of the Rajghur where it was naturally drained though water was plentiful below."

May be Grown on Waste Lands.

210. ***Conclusion.***—The above abstract of reports and opinions seems to confirm on all points the expectations I originally held out in a paper written in 1887-88 and published in the Selections from the Records of the Government of India.

Easily Separated.

Decorticator.

Conf. with para 165 (22).

The *bon-riha* is a plant that can be grown on soils that the true rhea plant could not live on. It would require next to no cultivation. There is no difficulty in separating the ribbons of bark since they do not adhere so firmly to the central core of wood as in the true *riha*. The bark strips off like that of a willow and a machine that would slit the bark and then peel it off might easily enough be devised. Once so stripped the ribbons could be laid flat on a feeding table and scraped both top and bottom, without any injury to the fibre.

* It will be recollected that I have already pointed out that the rhea fibre is in various parts of India cleaned by being boiled in rice-water. I have suggested that this fact should be chemically investigated.—*G. Watt.*

JABAKA NAGA.

No Mechanical Difficulties.

Comparative Values of the Fibres.

None of the mechanical difficulties that beset the rhea industry seem to me to exist in this case. The gum is easily scraped off, and it is by no means so abundant nor so difficult of removal as in rhea. Even if the fibre be considerably less valuable than the true rhea, it could be produced as a by-crop in tea-planting, could be easily and cheaply cleaned, and might thus be turned into the market at a price that would at once command a ready sale.

Remunerative By-crop to Tea.

Could be Grown in the *Hullahs.*

I do not say that the introduction of this fibre is likely to solve the rhea production problem. But from what I already know of this wonderful and greatly neglected fibre, I have very little hesitation in affirming that the tea-planters in Assam are likely to find the *bon-riha* a more tractable and remunerative by-crop than rhea fibre itself. It could be grown on the sloping banks of most of the depressions or *hullahs* within the tea estate—lands which at present are not only waste but often sources of positive danger to the tea-plant The annual crop of shoots from the perennial bushes would be found money and the supply of ribbons could be scraped by hand labour at a very moderate cost—the total charge in fact against production But no doubt machinery could be designed to greatly reduce even the cost of separation and cleaning.

IV.—Maoutia Puya, *Wedd. in Ann. Sc. Nat. Ser. 4 I, 195; Fl. Br. Ind., V., 592;* URTICACEÆ.

PUA-HEMP: NEPAL RHEA.

211. ***Syn. and References***—*Brandis, For. Flor., 436: Kurz, For. Flor., Burm. II, 429: Gamble, Man. Timbs, 325: Atkinson, Him. Dist., 317, 798:* BŒHMERIA PUYA, *Hook., in Journ. Bot., Vol. I. (1849), p. 26: also III. (1851), p. 316, t. 7 (Exclo. Syn. Roxb.):* B. FRUTESCENS, *Don Prod.* 59 (*not of Thunb.*) URTICA PUYA, *Ham. in Wall. Cat. 4605: Royle, Fib. Pl. 368: Campbell, Journ. Agri.-Hort. Soc. Ind, VI., 135, 142, 240: Hannay, Journ. Agri.-Hort Soc. Ind., VII., 223: Madden, Journ. As. Soc. Bengal XVIII. I., 622, Watson, Report Preparation and Uses of Rhea Fibre (1875), 34 (reprint from Hooker, Journ. Botany, Vol. III.).*

212. ***Vern. Names.***—*Poi, pua,* Hind.; *Yenki,* Limbu (Sikkim); *kyinki, kienki,* Lepcha (Sikkim); *Puya,* Kumaon, and *Putlanti,* Almora in the North-West Provinces it appears often to be called *banrhea* (wild rhea); *Puya,* Nepal; *Sat sa,* Burma. There would appear to be several plants that go even more generally than Maoutia by the name *Sat sa, sat-sha* or *sap-sha.* Of this nature I would mention Trema orientalis, Sarcochlamys pulcherrima and Bœhmeria Hamiltoniana as plants that belong to the same natural order and yield fibres of similar character to that of Maoutia Puya which seem in Burma to all receive the same vernacular name.

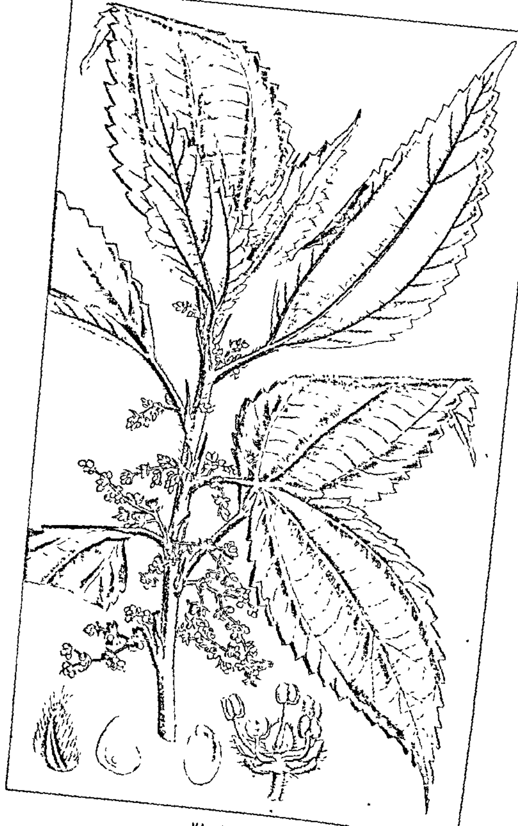
213. ***Description.***—A shrub 2 to 6 or 8 feet in height, branches pubescent. *Leaves* alternate, on fairly long and slender petioles, [illegible] to 6 inches long [illegible]

[illegible]

[illegible] stipules lanceolate very hairy. *Inflorescence* axillary and terminal cymes, dichotomously branched, slender. *Flowers* minute sessile or nearly so, monœcious or diœcious, in small heads: *male* heads larger than the female, stamens 5 opposite sepals: *female* perianth ovary straight stigma penicillate; achene gibbously ovoid trigonous adpressed-hispid ovule erect.

Plate No. IV has been reproduced from Hooker's Journal of Botany, Vol. III., Pl. 7.

M. 260-265.



214. ***Habitat***—Fairly plentiful in the damp forests at the foot of the Himálaya from Garhwal eastwards to the Khasia Mountains and Burma.

215. ***History.***—Dr. Campbell, while Superintendent of Darjeeling, wrote an account of this fibre in 1847 which was published in the Journal Agri.-Horti. Society of India, and has been re-published under numerous editoral transformations by every subsequent writer on this fibre. The specimens collected by Dr. Campbell were subsequently identified by Dr. Falconer, at that time Superintendent of the Royal Botanic Gardens, Calcutta. I have already mentioned the circumstance of the only specimen in the Calcutta Herbarium collected by Dr. Campbell having been wrongly named **Maoutia** or rather "*Pooah*". Mr. C. B. Clarke detected that a mistake had been made, and wrote on the sheet the correct name of the specimen, namely, **Bœhmeria nivea.** Whether that was the identical specimen said to have been examined and named by Dr. Falconer I am unable to say, but I completely concur with Mr. Clarke's determination that that particular sheet of "*Pooah*" (which was collected no doubt by Dr. Campbell) is the typical form of rhea But under the cover of **Maoutia** Mr Clarke himself had named some of his own early collections of this plant as **Bœhmeria nivea** and subsequently corrected them into **Maoutia Puya.** Whether this circumstance can be viewed as accounting for his having said that rhea was *wild* in Assam I am unable to say. But there seem no doubt that several Indian botanists made the mistake of confusing **Maoutia Puya** and **Bœhmeria nivea.** The instance I have mentioned of the name having been corrected, is by no means a solitary one, in the fairly extensive series of samples that I have examined The point is of historic value since it has a direct bearing on the story of rhea in India. I should not otherwise have regarded the correction of a name on a few sheets of herbarium specimens as of consequence. But if doubt be thrown on the determination of Dr Campbell's "*Pooah*" which I strongly suspect must be done, then practically the entire literature of this fibre may have to be regarded as cancelled But there are certain passages in Dr. Campbell's description that agree fairly well with **Maoutia** in fact better than with **Bœhmeria nivea,** so that it may be that Dr. Campbell's description is what he saw of *Pooah* and his specimens supplied to Hergaria, may have been derived from the cultivated plant of Rungpur (*Conf. with para. 46*).

Original Discovery Possibly Confused with Rhea
Conf. with paras. 19, 46.

Confusion Regarding Specimens.

Probable Explanation of Report of Rhea being Wild.
Conf. with para 17.

Rhea and Puya Confused.

MAOUTIA Puya.

Pua-Rfha.

Inferior Quality of the Fibre.

The examination of the fibre made by myself, on several occasions, revealed so little merit that I have been unable to understand why it had been highly extolled. But if the *Puya* of Darjeeling and Nepal which was examined and reported on by experts in Europe half a century ago, was in reality rhea and not *poi* or *puya*, then there is no difficulty in accepting the reports.

216. ***Chemical Examination.***—Messrs. Cross, Bevan & King show that this fibre should be regarded as very inferior. It lost 62·7 per cent. by hydrolysis and contained only 32·7 per cent of cellulose The sample was, however, ribbons of uncleaned bark. But these chemists remark "not only was the specimen inferior in point of preparation, but it was found in the microscopic examination, impossible to isolate the ultimate fibre, by reason of its breaking up under the needles. Many of the fibres of the *Urticaceæ* show this tendency to brittleness; but with special attention to cultivation and the conditions of growth, these defects can in all probability be removed."

217. ***Re-investigation Necessary.***—As matters stand, however, I think it preferable to urge that the available information regarding this fibre is so extremely confused and imperfect, but it would be preferable were the subject re-investigated from first to last With this object in view it may be as well if I put on record here Dr. Campbell's original communication regarding it and the report that was made on his samples. These papers may not be accessible to some of the readers of this Ledger and may accordingly be accepted as making the present sketch as complete as possible:—

Dr. Campbell's Original Report on Pooah Fibre.

218. "I have the pleasure to bring a new sort of hemp to the notice of the Society on behalf of Serjeant Crutcher, who is a professional worker in leather, and uses it in his craft. The Serjeant considers it equal to Russia hemp, for shoe and saddlery work, and purposes, if a demand shall arise for it, to prepare and supply it to the Calcutta market."

"I shall shortly describe the plant, the method of preparing the hemp with some other particulars, and will request of you to be so kind as to have it submitted to a comparative trial with the *sunn* and European hemps, and favour me with the result: also adding, if possible, the price it would fetch per maund in the Calcutta market"

"***Description of the Plant.***—The plant from which the hemp is made is called *Pooah* by the Parbuttias, *Kienki* by the Lepchas, and *Yenki* by the Limboos. It is like a nettle, and is one probably, although I cannot

determine the question. I have, however, the pleasure to submit herewith the leaves, seeds just formed, and a portion of the stem of the plant from which the genus, if not the species, may be determined. It grows to the height of 6 or 8 feet, and varies in the thickness of the stem from the size of a quill to that of the thumb. The leaf is serrated, of a dark-green colour above, silvery-white below, not hairy or stinging, and has a reddish pedicel of about 3 inches long. The seed forms in small currant-like clusters along the top of the plant, and on alternate sides about an inch apart two small leaves spring from the stem at the centre of and above each cluster of seed."

Campbell's Poaah. *Conf with para 215.*

219 "***Habitat.***—The *Poaah* is not cultivated, but grows wild and abundantly in the valleys throughout the mountains of Eastern Nipal and Sikkim, at the foot of the hills skirting the Tarai to the elevation of 1,000 or 1,200 feet, and within the mountains up to 3,000 feet. It flourishes best in the hills at the same elevation to which the cotton is grown, but it does not, so far as I can learn, grow on the flat Tarai or open plain along the mountains. It is considered a hill plant, and not suited to the plains or found in them. It does not grow in the forest, but is chiefly found in open clear places; and in some situations, overruns the abandoned fields of the hill people within the elevations which suit it. It is, I believe, a perennial, but of this I cannot speak positively, as I have not till now known the plant. It sheds its leaves in the winter, throws them out in April and May, and flowers and seeds in August and September. The exact period altering of necessity with the elevation."

220. "***When used.***—It is cut down for use when the seed is formed. This is the case with the common flax in Europe. At this time the bark is most easily removed, and the produce is best. After the seed is ripe, it is not fit for use, at least it is deteriorated."

221 "***How prepared.***—As soon as the plant is cut, the bark skin is removed. This is very easily done It is then dried in the sun for a few days; when quite dry, it is boiled with wood-ashes for 4 or 5 hours; when cold, it is beaten with a mallet on a flat stone, until it becomes rather pulpy, and all the woody portion of the bark has disappeared; then it is well washed in pure spring water and spread out to dry. After exposure for a day or two to a bright sun it is ready for use. When the finest description of hemp is wanted, the stuff after being boiled and beaten, is daubed over with wet clay and spread out to dry. When thoroughly dry, the clay is rubbed and beaten out, when the hemp is ready for spinning into thread, which is done with the common distaff."

222. "*Uses.*—The *Poaah* is principally used for fishing nets, for which it is admirably adapted on account of its great strength of fibre and its extraordinary power of long resisting the effects of water. It is also used

for making game-bags, twine and ropes. It is considered well adapted for making cloth, but is not much used in this way. I have the pleasure to forward the following specimens in elucidation of this note.:—

1. Leaves of the plant.
2. Seed clusters.
3. Portions of the stem.
4. The dried bark.
5. The prepared hemp.
6. Thread.

DARJELING;
September 24th, 1847.

A. CAMPBELL.

P.S.—"In compliance with your request I forwarded to your address a packet of the *Pooah* hemp, which will, I hope, enable you to have the experiment instituted as to its comparative merits. I have also sent you a parcel of the dried bark of the *Pooah*, with which you may perhaps desire to try some other mode of preparation than that in use here."

"Enclosed is a note from Serjeant Crutcher on the expense of preparing the hemp, which shows that the process in his hands has been very expensive. He tells me, however, that he thinks it may be prepared for about R4 per maund, if done on a large scale; this of course is still conjectural. The point to be first ascertained is the quality of the article. On this I hope again to learn the opinion of the Society."

Report by Captain A. Thomson on Dr. Campbell's Pooah Fibre.

223. "Of the *Pooah* I have to report more favourably. The substance resembles cotton-wool more than hemp, consequently better adapted, in my opinion, for sail cloth, twine, and thread than for rope. I send a specimen of the cloth, made of it, as also a piece of line. The *Pooah*, when properly dressed, is, I think, quite equal to the best Europe flax, and will produce better sail cloth than any other substance I have seen in India. I observe from Dr. Campbell's communication on this fibre, that mud is used in the preparation, which clogs it too much, and not only renders it difficult to dress and spin, but spoils the colour, as is evident by the sample of cloth made of it. My Superintendent, Mr. William Rownee, who understands the nature of these substances, tells me, that if potash were used in the preparation (which is invariably done with Russian hemp and flax) instead of clay or mud, that the colour would be improved, the substance rendered easy to dress, and not liable to so much waste in manufacturing."

"The value of the *Pooah* fibre here may be estimated from the following data. To make one yard of sail cloth it requires 1lb 2 oz. of fibre,

MR. GAMMIE'S REPORT.

and the expense of dressing, spinning, and weaving it (with the rude apparatus now used by the natives), is 2 annas 6 pie, and I estimate the value of the cloth when made, at 6 to 7 annas per yard; or it may be easier understood, thus:—

	R
A maund of clean *Poosh* will give 72 yards . .	25
Less expense of manufacturing, say	10
Leaving as the value of the fibre	15

"There are other incidental expenses that are not included here, but as near as I can at present estimate, I should say it is worth twelve rupees per maund. I would only further observe that, if properly prepared and dressed, I think the *Poosh* capable of being converted into fibres much finer than either sail cloth or sewing twine." Calcutta, 31st December 1847.

224. ***Description by Mr. Gammie.***—The following article will be found of interest as supporting Dr. Campbell's description of the separation and cleaning of the *Puya* fibre:—

Memo. on the preparation of Poosh fibre taken from a letter by Mr. G. A. Gammie, *Mungpoo, to the Superintendent, Botanic Gardens.*

"The whole sample has been prepared by the method pursued by the Nepalese and Lepchas."

"The bark is peeled off the stems in long strips; boiled in water, thickened with common wood ashes until it is pulpy; then as much as possible of the adhering bark is separated from the fibre by alternately beating with a wooden mallet and washing in cold water. After this the water is rinsed out, and each bundle of fibre is thickly covered with a paste of micaceous clay, and dried. When thoroughly dry, the clay and the remaining bark are easily shaken off, leaving the fibre in a state fit for use. If fibre is required free from dust, it is repeatedly rinsed until the water runs clear, and then re-dried."

"The white or bluish white clay found here and there, near streams is preferred, as it gives the fibre a good colour"

"If the appearance of the fibre is of no consequence, yellow clay is said to be as effective."

"I do not know whether the action of the clay is altogether mechanical or not. A few samples which were prepared by treatment with lime and chalk were coarse in appearance and rough to the touch; those treated by clay, on the other hand, were soft and silky. Although the *Poosh* is rather a common plant, it is seldom gregarious to any extent as far as I know; so that the collection of a large quantity entails

MR. GAMMIE'S REPORT.

an expenditure which must exceed the value of the fibre extracted. I obtained five maunds of stems, by contract, for three rupees per maund, but I question if I could obtain them at the same rate again, as the people had to search far and wide for even that quantity. At a moderate estimate the further cost to manufacture the fibre was five rupees,—making a total of twenty rupees."

"The fresh stripped bark weighed 63℔ and yielded only 4℔ of fibre. The cost of producing one pound of fibre would therefore be five rupees.

"*Poaah* is chiefly used for fishing nets and lines. I am told that formerly the Lepchas made cloth from it, but the contraction and expansion readily caused in it by atmospheric changes made it uncomfortable and undesirable for wearing apparel."

225. ***Conclusion.***—I have no reason to doubt but that the fibre Mr. Gammie witnessed being cleaned was **Maoutia Puya.** The fibre appears to be used by the hill tribes of Nepal and Sikkim, but we know comparatively little about its chemical and physical properties. Mr. Gammie's description lends, however, considerable support to the opinion that Dr. Campbell's description at least was actually that of **Maoutia,** but there remains the unanswerable fact that the botanical specimens he sent to Calcutta as *Pooah* were those of rhea. A further circumstance may be here mentioned. Dr. Buchanan-Hamilton was the discoverer of *Kankura* cultivation (**Bœhmeria nivea**) in India and may be presumed to have taken some interest in the subject. In his *Account of the Kingdom of Nepal* (published 1819) (which embraces that of Garhwal and Kullu) he makes no mention of either *Poi* or *Kankura.*

APPENDIX I.

RHEA-EXTRACTING MACHINERY.

FIRST OFFER OF A REWARD.

226. A Notification of the Home Department, No. 145, published on the 11th January 1870, was to the following effect :—

grass, is the want of suitable machinery for separating the fibre and bark from the stem, and the fibre from the bark, the cost of effecting such separation by manual labour being great.

"2. The demand for the fibre is now large, and no doubt might be extended with reduced prices, and there is a practically unlimited* extent of co

* *Conf. with p. 8.*

proce
powe
than
facture and allowance for wear and tear included) of not more than £15 per ton," etc.

"2. To stimulate the invention or adaptation of such machinery or process, the Government of India hereby offer a prize of £5,000 for the machine and process that best fulfils all the requirements named above," etc

years from the same date, after which, or on the award of the prize, the offer herein named will be withdrawn."

SECOND OFFER OF A REWARD.

227 By Notification No 45, of the 31st August 1877, the Government of India a second time made known its willingness to give a substantial award to the inventor of a process or contrivance that might be found to fulfil the specifications of a Rhea-fibre-extracting machine.

In this second notification the following passages occur :—

"Fifty thousand rupees will be paid to the inventor of the best

process capable of producing, by
dressed fibre of a quality which
ts in the English market, at a total
tion and all needful allowance for
wear and tear, of not more than £15 per ton, laid down at any port of

B. 576-606.
R. 172-213.

BŒHMERIA nivea. | *Rhea (Riha) or*

SECOND OFFER OF A REWARD.

shipment in India and £30 in England after payment of all charges usual in trade before goods reach the hands of the manufacturer.

"The machinery employed must be *simple, strong, durable and inexpensive*, and should be suitable for erection in the plantations where the rhea is grown. It must be adapted for treatment of the fresh stems as cut from the plant. The treatment of dried stems offers certain diffi- ... much ... during ... ifficult ... But ...

It is therefore obvious that the attention of inventors should be given to the discovery of a process for treatment of the green stems."*

* *Conf. with p. 5.*

It is perhaps needless to quote the minor details of the Notification here briefly indicated. The above passages will be found to not only convey the main principles enjoined, but to deal with certain peculiarities of rhea cultivation and of the requirements of the machinery necessary for India, and these hold good to the present time. The trials were fixed to commence on the 15th September 1879.

WITHDRAWAL OF REWARD.

228. The Government of India in a Resolution dated March 19th, 1881, reviewed the report of the Committee which had sat to examine the machines and *withdrew the offer of any further rewards.* The following passage occurs in that Resolution:—

"From the low valuation put by the English firms on the samples of fibre produced at the late competition, it does not seem probable that Indian rhea fibre will be able, for the present at least, to compete success- ...

Conf. with pp. 1, 6.

It will th ... result of these trials was to create a dou ... ing country, ... tised by the ... may, howeve ...

B. 576-606.
R. 172-213.

raised as to whether the Government of India still offers its reward for competition. Up to the present date the Government of India has not seen cause to depart from its Resolution of 1881, so that no rewards are at present offered for rhea-fibre-extracting machinery.

APPENDIX II.

Straits Settlements.

Since the foregoing was written, Dr. Prain has very kindly furnished the following extract, which affords information on the important point as to the period that must transpire between the time of sowing of Rhea seed, and that of gathering the initial crop of stems from the seeds thus sown:—

From C. Curtis, Esq., F.L.S., Forest Department, Straits Settlements, to Surgeon-Major D. Prain, M.A., M.D., F.R.S.E., dated Penang, the 20th October 1897.

I am fortunately able to answer your practical question on Ramie.

Ramie Stems cut 6 months after sowing.

On the 12th February this year I sowed some seeds of Ramie in a carefully prepared bed of light soil with protection from sun and rain. On the 2nd March the plants were 4 to 6 inches high, when they were lifted and put in 5-inch pots. A month later they were planted out in a bed 2 feet apart (this is too close, 3 feet would have been better), and the first cutting was made in the middle of August. This gives just exactly six months [in Penang] from seed sowing to cutting. I had a look at them again this morning. They completely cover the ground, and are ready for cutting a second time. This is a form that grows about 4 feet high and begins to flower early. In fact the stems are full of flower now.

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G. I. C. P. O.—No 39 R. & A —18-11-98 —2,350.—H. R.

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Editor, Dr. George Watt, Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series; those on Forestry in the Forest Series. Papers of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

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(THE WARAS DYE.)

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. III., F. 633-42.*]

THE ARABIAN DRUG WARAS OR WARS.

A Description of its History, Uses and Composition, with Remarks on its Occurrence in India. By THE OFFICIATING EDITOR.

Other DICTIONARY articles that may be consulted:

Mallotus philippinensis, *Vol V.*, M. 71-86.



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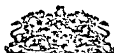
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(2) To secure the maintenance of uniform ledgers (on the plan of the Dictionary) in all offices concerned in agricultural subjects throughout India, so that references to ledger entries made in any report or publication may be readily utilised in all offices where ledgers are kept;

(3) To admit of the circulation, in convenient form, of information on any subject connected with agriculture or economic products to officials or other persons interested therein;

(4) To secure a connection between all papers of interest published on subjects relating to economic products, and the official Dictionary of Economic Products. With this object the information published in these ledgers will uniformly be given under the name and number of the Dictionary article which they more especially amplify. When the subject dealt with has not been taken up in the Dictionary, the position it very possibly would occupy in future issues of that work will be assigned to it.

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INTRODUCTORY.

This number of *The Agricultural Ledger* deals with the history and properties of the Arabian drug *Waras*, and the discovery of a similar substance on species of Flemingia growing in India. The report by Mr. A. G. Perkin, of the Research Laboratory of the Dyeing Department, Yorkshire College, Leeds, shows that the indigenous product is superior to *Kaméla* (Mallotus philippinensis) in imparting an orange colour to silk fabrics. All the available information on *Waras* is reproduced, for the sake of convenience, in the form of a revision of the article in the *Dictionary of Economic Products.*

Flemingia congesta, *Roxb. Fl. Br. Ind., II., 228; Wight Ic., t. 390;* LEGUMINOSÆ.

Vern.—*Bara-salpan, bhalia, supta cusuni,* HIND; *Bara-salpan, bhalia,* BENG.; *Buru ekasira nari, bir but,* SANTAL; *Batwasi,* NEPAL; *Mitpil muk,* LEPCHA; *Dangshukop,* MICHI; *Dowdowlá,* BOMB. and MAR., *Tha kya nai,* BURM

FLEMINIGA congesta.

The Arabian Drug Waras or Wars.

References.—Roxb., Fl. Ind., Ed. C.B.C., 572: Gamble, List of Trees, Shrubs, etc, of Darjeeling, 28: Dals. & Gibs., Bomb. Fl., 75: Science Papers, 73: Rev. A. Campbell, Report on Econ. Prod., Chutia Nagpur, No. 8465: Atkinson, Econ. Prod., N.-W. P., Pt. V., 94: Kew Report, 1881, 50: Kew, Off. Guide to Mus., 45: Report Bot. Gard. Nilgiris, 1884-85: Pharmacog., 573: Mat. Med., W. Ind, 708: Pharmacog. Ind., I., 420: Pharm. Journ., XII. (1853), 589 (Hanbury); [2] IX. (1867), 279, (Flückiger): [3] XIV. (1884), 897 (Kirkby); [3] XIV. (1884), 917 and 969 (Thiselton Dyer); [3] XVII. (1887) 1029, and XVIII. 110 (Flückiger); [3] XVIII. (1887), 213 (Hooper); Journ. Chem. Soc., Aug. 1898., 660 (Perkin).

HISTORY.

History.—Dr. Roxburgh about a century ago called attention to the fact that certain plants belonging to the genus Flemingia possessed on the surface of their pods a number of red-coloured glands. In his "Flora Indica" he remarks, that F. procumbens, a native of the mountains north of Oudh and Rohilkhand, had its legumes and calyx besprinkled with garnet-coloured grains, and that F. nana found in the vicinity of the Ganges towards Hurdwar, had its legumes densely enveloped with clammy reddish powder.

Plants yielding glands.

In Burma the pods of F. prostrata of Roxburgh have been found to be densely covered with purplish black resinous dots, and Kurz in "Forest Flora of British Burma," alludes to the presence of black resinous dots when describing the legumes of F. sericans (F. Wallichii, *W. and A.*), F. lineata, *Roxb.*, and F. ferruginea, *Grah.*

In the "Flora of British India" Mr. J. G. Baker has reduced all the above-named plants with the exception of F. Wallichii and F. lineata to one species, *viz.*, F. congesta; and F. Grahamiana, *W. and A.*, a Nilgiri and Burmese plant, also affording red viscous glands, is not far removed from it specifically.

Kamela.

The only other glandular product that bears any resemblance to that found on the pods of these leguminous shrubs is the red-coloured powder known as *Kamela* which is obtained from the capsules of a Euphorbiaceous tree, Mallotus philippinensis.

Kamela is a well-established dye in India and its botanical origin has been long known, but it is only within the last few years that Waras, an equally ancient drug, has been referred to a species of

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Flemingia growing in the East. The history of this discovery is of great interest in showing the difficulties experienced in tracing the source of products which lie outside the beaten tracts of European commerce.

Arabian accounts.

Arabian physicians as early as the tenth century mention this drug under the name of *Kanbil* or *Wars.* Ibn Khurdadbah, an Arab traveller living A.D. 869-885, states that "from Yemen came striped silks, ambergris, *wars* and gum." Kaswini in the thirteenth century was also acquainted with wars which he says was a plant sown in Yemen and resembling sesamum. Constantinus Africanus likewise spoke of *huars.* It should be remembered that Wars, Wors, Wurrus or Warras in Arabic are, properly speaking, terms signifying saffron, the origin, among a few other plants, of the auspicious yellow dyes of Eastern countries.

These earlier Arabian writers appear to have confounded the drug *kamala or kinbil* (the Sanskrit name converted into an Arabic form) with the waras produced in Arabia and Ethiopia. The red kinbil or waras mentioned by them was probably all imported from India as we have no evidence that Mallotus philippinensis grows in Arabia and North-East Africa.

Later authorities quoted.

In later writings these two drugs are more particularly distinguished, and an Abyssinian variety is described as being black and an Indian which is red. The author of the "Kamus" who wrote about A.H. 768, notices both kinbil and waras, and treats them as two distinct substances. He says of kinbil that it is red and astringent and that it kills and expels intestinal worms and cures scabby affections of the skin. Of waras he says the plant is like sesame and only found in Arabia; externally applied, it removes freckles, taken internally it cures leprous eruptions, but not a word is mentioned about anthelmintic properties. The author of "Makhzan" speaking of waras says there is a black kind, which comes from Ethiopia and it is called *habshi*, and a dull red kind, which is called Indian and is the worst as a dye; he concludes by remarking that the seeds of the waras are like *Mash* (Phaseolus Mungo, *var.* radiatus). It is described as aphrodisiac, lithontriptic and a remedy for ringworm, pityriasis and freckles.

The two drugs began to attract attention in England in 1853, when Dr. James Vaughan, Fort Surgeon at Aden, published

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his notes upon the drugs observed at Aden and other places in Arabia.

The following extract refers to the products under discussion :—

Dr. Vaughan's Notes.

"*Wurrus* or *Waras*, a red powder used chiefly as a dye, is the produce of a plant resembling sesame. I am informed that the plant rises to about five feet in height, bearing several separate bunches or clusters of small round seeds, which are covered with a description of pollen or flower; this removed from the seed-clusters by gentle rubbing or shaking, constitutes the dye; the seeds are afterwards thrown away. Two kinds of *Wurrus* are brought into the market. The best comes from the interior, principally from the towns of O Badan and Gebla and the districts of Yaffaee and Sjibul Rudfan. A second kind brought by the *Somalis of the opposite coast, comes from the neighbourhood of Hurrer*; this is not so much valued and does not realize the price of the other sort. A considerable quantity of the dye I find is exported to Bombay; it is used principally by the people of Surat for the purpose of imparting a light brown yellow colour to their silks, which are much prized and worn by the Native ladies. I believe that *Wurrus* is used for silks only and not for cotton or woollen stuffs. Besides being employed by the Arabs of this part as a dye, the colour produced being highly esteemed, they use it likewise as an internal medicine in cases of leprosy, and externally in solution as a lotion to remove freckles and pustules. Much of this dye finds its way to the Persian Gulf, where it is known under the name of *Asberg*. *Wurrus* sells in Aden for about twenty-four rupees the maund, but the African or inferior description realizes only from seventeen to eighteen rupees the maund."

Mr. D. Hanbury remarks that the Wurrus of which two samples had been received from Mr. Vaughan consisted of a dull red, granular, sand-like powder, mixed with small fragments of stalk and leaves, and presumed that it was the *wars* of Niebuhr, which he speaks of as "herbe qui teint en jaune et dont on transporte quantité de Mocha dans l' Omân" (see "*Description d' Arabie*," Amsterdam et Utrecht, 1774, p. 133).

Identification of Wurrus.

Mr. Hanbury carefully examined this powder and assigned to it its proper position in the vegetable kingdom in a paper subsequently read that year on "Wurrus, a dye produced by Rottlera tinctoria." The latter name of the plant given by Roxburgh is now changed by botanists to that of Mallotus philippinensis of *Mueller Argoviensi*. The glandular powder called kamala was made official in the British Pharmacopœia of 1867, but its use as a medicine has

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gradually declined, and it has been omitted from the recently published Pharmacopœia of 1898.

Confused with other dyes.

Many conjectures were made as to the source of the second kind of kamala or waras and Dr. Sprengel suggested that it was obtained from **Memecylon tinctorium, (M. edule,** *Roxb.*,) the leaves of which are used in India for dyeing silk. No glands, however, have *been found upon any part of this shrub.* The Asberg alluded to in Mr. Vaughan's note as being sold in the Persian Gulf ports is now considered to be the drug known under the various synonyms *Asperag, Tráyamán,* and *Zalil.* This consists of the dried herb **Delphinium Zalil** of Aitchison and Hemsley, growing in the moister localities of the Badghis and Khorasan, and exported from Persia as a yellow dye.

Imported from Aden.

In 1867 an authentic supply of waras was imported from Aden by Messrs. Allen and Hanbury, London. It arrived neatly packed in oblong, white calico bags of three sizes each inscribed with Arabic characters, indicating the name of the vendor or collector, a native of Hurrur, a town in Eastern Africa which is a great trading station between the Galla countries and Barbera; the net weight was either 100, 50 or 25 Turkish ounces. No more than two supplies, in all 136℔, could be obtained.

Professor Fluckiger's examination.

The drug was submitted to a microscopical examination by Professor F. A. Fluckiger, of Strasburg, who noticed that it was in coarser particles than kaméla, it had a deep purple colour and a distinctly peculiar odour. It had evidently been carefully collected and was free from earthy admixture, yet it left upon incineration 12 per cent. of ash. It blackened at a temperature of 100° C, losing 5·2 per cent. of water; kaméla under such circumstances undergoes no change of colour.

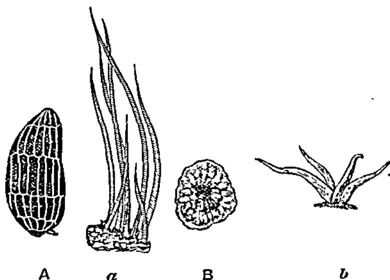
Under the microscope waras presented still greater differences, the grains being cylindrical or sub-conical, 170 to 200 mm. long by 70 to 100 mm. broad, and therefore much larger than kaméla glands. The grains are furnished with oblong resin cells arranged perpendicularly in three or four storeys or stages, containing about twenty cells in each stage, very dissimilar to the radiate arrangement seen in ordinary kaméla. The grains were mixed with a few long colourless, transparent, simple hairs, not stellate or tufted as in the allied drug.

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FLEMINGIA congesta.

The Arabian Drug Waras or Wars.

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A.—Gland of Flemingia pods.
a.—Simple hairs of ditto.
B.—Gland of Mallotus philippinensis.
b.—Tufted hairs of ditto.

Description of waras.

The above illustrations are reproduced from those given by Professor Fluckiger in his paper written in 1867, on "A New Kind of Kamala." It is at once seen that, apart from the dissimilar structure as observed under the microscope, it differs from the Mallotus glands in the larger size and deeper colour of the grains.

A Swiss firm in Aden sent to Professor Schaer, in 1878, a powder under the name of *Vars* which was identified with the above. It was said to be used chiefly in the coast districts of Muscat (Oman) and Hadramaut, in skin diseases and as a dye.

Efforts were made in different quarters to ascertain the botanical source of the purplish-red powder. At the suggestion of Professor Fluckiger, Major Hunter, the Assistant Resident at Aden, kindly interested himself in the matter and succeeded in obtaining specimens of the plant said to yield the Arabian waras. A dried plant was also sent to Kew with a note stating that it was gathered at an elevation of 6,000 feet on Jebel Dthubarah, 60 miles due north of Aden. The plant was immediately identified with the leguminous

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shrub Flemingia congesta, *Roxb.*, and the fact was announced in the "Kew Report" for 1880.

Major Hunter's Notes.

The following interesting Notes on the collection of the dye at Harrar were contributed by Major Hunter, and published by Mr. W. T. Thiselton Dyer, C.M.G., C.I.E., F.R.S., Director of the Royal Gardens, Kew:—

"In the neighbourhood of the city 'wars' is not now raised from seed sown artificially, and it is left to nature to propagate the shrub in the surrounding terraced gardens. The plant springs up, among jowari (Andropogon Sorghum), coffee, etc., in bushes scattered about at intervals of several yards more or less. When sown, as among the Gallas, it is planted before the rains in March. If the soil be fairly good a bush bears in about a year. After the berries (pods) have been plucked the shrub is cut down to within six inches of the ground. It springs up again after rain and bears a second time in about six months, and this process is repeated every second year until the tree dies. Rain destroys the berry (pod) for commercial purposes; it is, therefore, only gathered in the dry season ending about the middle of March. The bush grows to a maximum height of six feet, and it branches close to the ground. The growth is open and the foliage sparse. Each owner has a few acres of land.

"In the middle of February, 1884, the following processes were observed:—

"The leaves [? fruiting shoots] of some plants were plucked and allowed to dry in the sun for three or four days. (The picking is not done carefully and a considerable quantity of the surrounding twigs, etc., is mixed with the berries [pods]). The collected mass was placed on a skin heaped up to about six or eight inches high and was tapped gently with a short stick about half an inch thick. After some time the pods were denuded of their outer covering of red powder which fell through the mass on to the skin. The upper portion of the heap was then cleared away and the residual reddish-green powder was placed in a flat woven grass dish with a sloping rim of about an inch high. This receptacle was agitated gently and occasionally tapped with the fingers, the result being the subsidence of the red powder and the rising to the surface of the chaffy refuse which latter was carefully worked aside to the edge of the dish and

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then removed by hand. This winnowing was continued until little remained but red powder. (No great pains are even taken to eliminate *all* foreign matter.) A *roll* was sold in 1884 for about 13 piastres = 1 rupee 10 annas nearly.

Uses.

"'Wars' is sent to Arabia, chiefly to Yemen and Hadhramaut, where it is used as a dye, a cosmetic and a specific against cold. In order to use it, a small portion of the powder is placed in one palm and moistened with water, the hands are then rubbed smartly together, producing a lather of a bright gamboge colour, which is applied as required."

Botanical source.

Subsequent consignments of the waras plant from Aden, through the assistance of Major Hunter, were forwarded to Kew and they were found to bear a close resemblance to F. rhodocarpa, *Baker*, a plant discovered previously at Mozambique and characterised by having its pods covered with a bright-red, resinous pubescence. A sample of Somali waras received in 1883 was mixed with seeds of a dull brown colour mottled with black; this description applies to the seeds of F. rhodocarpa, *and a further scrutiny led to the conclusion* that this or an allied species was the origin of waras. Professor Oliver subsequently discovered that F. Grahamiana, apparently confined to South India was not specifically distinguishable from the African plant F. rhodocarpa, as the pods were clothed with the same peculiar epidermal glands.

Discovery on the Nilgiris.

Mr. M. A. Lawson, about this time (1883), was appointed Government Botanist of Madras and Director of the Cinchona Plantations, Nilgiris, and he was invited by Mr. Thiselton Dyer, to examine the Flemingias in the neighbourhood with the object of more particularly investigating the epidermal glands said to be attached to the pods. Mr. Lawson succeeded in collecting several ounces of the powder which was the produce of F. Grahamiana and F. congesta.

F. Grahamiana.

F. congesta.

"With respect to the distinctive characters of these two species," he wrote in the annual report, "I pointed out that after studying the plants in their living condition, I did not think them sufficiently constant to allow of the two species being kept separate, and in this opinion both Mr. Thiselton Dyer and Professor Oliver now concur. F. congesta is the hill form growing on more or less exposed places, while F. Grahamiana grows at lower elevations and in woods."

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The Arabian Drug Waras or Wars. (*D. Hooper.*) FLEMINGIA congesta.

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Through the kind offices of Dr. D. Prain, I have been permitted to examine all the Indian flemingias preserved in the Herbarium of the Royal Botanic Garden, Sibpur. The pods of a goodly number of the forms were observed to yield more or less the glandular powder, but it was particularly evident on F. Grahamiana, *Wight*, F. congesta *var.* Wightiana (F. Wightiana, *Benth.*) and F. Wallichii, *W. & A.* Dr. Prain considers the Grahamianian species to be quite distinct from F. congesta. All the mounted plants of this genus whether they afforded the glands or not were capable of staining the paper on which they were fixed an orange-yellow colour, owing to the employment of alcoholic solution of corrosive sublimate in poisoning them.

Collection.

On the Nilgiris the fruits ripen in the cold weather during December and January when they are covered with the peculiar red glands. The drug is collected by cutting off the clusters of pods from the ends of the branches and placing them in the sun to dry for one or two days. They should be placed on boards or paper, as during the process of drying much of the powder falls, and would be lost unless such a precaution were taken. The pods are then pressed or rubbed together by hand over sieves. The powder will be found to be mixed with hairs, stones and pieces of stalk; from these impurities it is readily removed by finally passing it through a fine muslin or lawn sieve.

Waras not a trade article.

Although the plants occur pretty frequently in India very little seems to be known by the natives of their colouring or medicinal properties, and from enquiries made of local traders, no information could be gleaned of the powder being a marketable article. At an exhibition of the Agri-Horticultural Society of Madras held a few years ago, some of the powder was said to be shown by a native dyer, but this has not been observed since, and kamela is the usual vegetable dye used for colouring silk in Madras.

Known by Santals.

Rev. A. Campbell, in a report on the economic products of Chutia Nagpur, writes of F. congesta:—"The pods are said to yield a dye." It would thus appear that the Santals are to some extent familiar with the nature of the shrub.

Further uses of the plant.

The plants are not sought after by the natives as they appear to have very little virtue either in medicine or food. Atkinson reports that the pods are occasionally eaten in the North-West Provinces,

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and Rev. Mr. Campbell informs us that the roots are employed by the Santals as an external application to ulcers and swellings, mainly of the neck.

F. tuberosa.

Flemingia tuberosa, *Dalz.*, a native of the Konkan, affords tuberous roots which are eaten either raw or roasted, and are considered medicinal. **F. vestita**, *Benth.*, of Assam, yields a tuber known as *Sophlang*, which is grown as a crop similar to the potato. It is interesting to notice that the leaves of these two plants are studded with minute golden glands which consist of a pigmental resin.

F. vestita.

CHEMICAL COMPOSITION.

Chemical Composition.—The resinous colouring matter which constitutes the chief part of waras has a brittle consistence; it is of a deep garnet-red colour in bulk and orange-red when observed in thin strata. It is soluble in ether, alcohol, chloroform, acetic acid, and in solutions of potash, soda and ammonia and the alkaline carbonates. Sulphuric acid dissolves it in the cold. Heated with nitric acid it rapidly oxidises, yielding yellow-coloured products and a resin soluble in alcohol. Heated with potash or soda an odour of citron is evolved. An ethereal solution of the resin allowed to evaporate spontaneously deposits a mass of crystals. The crystals are lighter in colour than the surrounding red resin, and examined microscopically, they appeared as crops of acicular prisms radiating from a common centre. The name "flemingin" was suggested for these crystals when the writer analysed the drug in 1887.

Besides the resinous and crystalline principles of waras, there are albuminous and saccharine matters soluble in water, an amount of ash varying between 5 and 12 per cent., and a trace of volatile oil. The following results of an approximate analysis of waras made by the writer are reproduced, together with an analysis of kaméla made by Dr. Thomas Anderson, of Glasgow, in 1855 :—

Proximate analysis.

	Waras.	Kamela.
Resinous colouring matters	72·83	78·19
Albuminous matter, etc.	8·20	7·34
Cellulose	9·50	7·14
Water	3·44	3·49
Ash (principally sand)	6·03	3·84
Volatile oil	trace	trace
	100·00	100·00

Mr. Perkin's analysis.

A chemical examination of waras has very recently been made by Mr. Arthur George Perkin, F.R.S.E., whose invaluable researches in the natural colouring matters of India are well known. The

CHEMICAL COMPOSITION.

results of the investigation were communicated to the Chemical Society of London in a paper entitled "Constituents of the Indian Dye-stuff Waras, Flemingia congesta" (*Journ. Chem. Soc., Aug. 1898*). At the instance of the authorities at the Imperial Institute the sample consisting of a few ounces of the powder had been collected at Naduvatam, on the Nilgiri Hills, and was forwarded to London through the Reporter on Economic Products to the Government of India.

The analysis resulted in the isolation of the following constituents:—

Flemingin.

Flemingin $C_{12}H_{12}O_4$, is a dull orange-red crystalline powder, consisting of small prismatic needles melting at 171-172°. In appearance and numerous properties it resembles the rottlerin of kamala, but is distinguished from this by its solubility in alcohol and acetic acid, and by the browner tint of its alkaline solutions. In an alkaline bath, it dyes silk a golden yellow and is a stronger dye-stuff than rottlerin. On fusion with alkali it gave acetic acid, salicylic acid and an acid of higher melting point which was not identified.

Homoflemingin.

Homoflemingin (C=69·97; H=5·75), a yellow colouring matter, present only in minute quantity, forms glistening yellow needles, melts at 164-166°, and possesses properties resembling those of flemingin.

Resins.

Resin of high melting point, $C_{12}H_{12}O_3$, forms a brick-red powder soluble in alkali with a deep brown tint and yields acetic and salicylic acid on fusion with alkali. It dyes silk in shades which are redder than those produced by flemingin.

Resin of low melting points $C_{13}H_{14}O_3$, is a deep orange-brown transparent mass which melts below 100°, is soluble in alkali with an orange brown colour and closely resembles the resin of low melting point of kamala. On fusion with alkali, acetic and salicylic acids are obtained, and on boiling with nitric acid (sp. gr. 1·5) oxalic acid is formed.

Summary.

Mr. Perkin summarises the results of the examination in the following terms:—"This investigation indicates that waras contains five distinct substances, namely, flemingin, homoflemingin, resins of high and low melting points, and a wax. Although these are not identical with any constituent of kamala, the analogy between these

FLEMINGIA congesta. The Arabian Drug Waras or Wars.

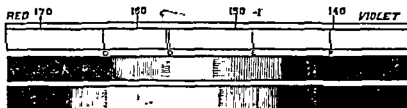
CHEMICAL COMPOSITION.

drugs is remarkable, for from the latter rottlerin, homorottlerin, a high and low melting resin and a wax can be isolated. The products from both sources, moreover, have many special characteristics in common, and there can be but little doubt that a close chemical relationship exists between them. The kamala substances contain, as I have previously pointed out, a cinnamyl nucleus, and thus, by decomposition with alkali, give benzoic and acetic acids; those from waras, on the other hand, yield in the same way salicylic and acetic acids, which suggests they may contain a hydroxycinnamyl group."

PHYSICAL PROPERTIES.

Spectrum of Waras.—The physical properties of the colouring substances were examined by preparing separate tinctures of waras and kamela, and observing each by means of a spectroscope. The tincture of waras had a deeper red colour than that of kamela and was mixed with more spirit to make the two tinctures resemble each other in tint. Nothwithstanding the dilution, the spectrum of waras showed more absorption than the kamela. There was complete absorption at both ends of the spectrum, and no darkness in either case at the Fraunhofer line D. The only difference of note was that the soluble constituents of kamela were transparent to a light of somewhat greater wave length than waras. No absorption bands were visible in either spectrum. The accompanying illustration shows the peculiarities of the spectra of the two pigments. It is reproduced from an article printed in the *Proceedings of the Royal Society of Edinburgh* for 1890 on "The absorption spectra of certain vegetable colouring matters," contributed by Prof. O. Michie Smith, of Madras.

Spectrum.



DYEING PROPERTIES.

Dyeing Properties.—Waras like kamela is an excellent dye for silk, but is not suitable for linen or cotton. Mr. (now Sir Thomas) Wardle, of Leek, undertook in 1884 to examine the dyeing properties of waras, a sample of which had been collected by Mr. Lawson on the Nilgiris. Mr. Wardle reported that the substance

DYEING PROPERTIES.

contained a small amount of colouring matter compared with the vegetable yellow dyes of commerce and no colour could be obtained from it which would compare in depth and richness with those produced by kamela. Waras also appeared to be inferior to kamela in permanence as regards the action of light. The colour of waras was noticed to easily turn brown by alkaline solutions, whilst kamela is only slightly reddened. Both dyes, however, resist the action of acids very well. Waras was tried on cotton with and without mordants, and the result was a pale shade of yellow.

Mr. Perkin offers the following remarks as the result of his experiments with this pigment:—"Suspended in a boiling solution of its own weight of sodium carbonate, waras readily dyes silk golden yellow shades, very similar to those produced by kamela, but slightly duller and more orange. Material was not available for extended study of its tinctorial properties, but it was at once evident that, in strength, waras is a decidedly superior dye-stuff to kamela. Whether it is capable of competition with the yellow dye-stuffs of commerce cannot be determined until larger quantities can be procured for more extended work in this direction. In the meantime, I shall be grateful for information which will enable me to obtain a supply of this material."

Superior to Kamela.

The opinions of the two experts are somewhat divergent considering the fact that the samples had been gathered from similar plants growing in the same district of South India. The powder used by Mr. Wardle was slightly mouldy and had been damaged owing to the excessive wetness of the season; on the other hand, the specimen sent to Mr Perkin had been procured in the dry weather and was despatched without delay in a stoppered bottle.

Divergent opinions.

The larger proportion of resinous colouring matter in the waras, the richness of its solutions, and the absorptive power observed in a spectrum, indicate its superiority over kamela, and confirm Mr. Perkin's conclusions.

Notwithstanding the wide distribution of Flemingia plants in India the glandular hairs peculiar to some species are at present not much more than a botanical curiosity. Now that attention has been drawn to the Arabian trade in an identical substance and to the delicacy of the dye from an indigenous source, it is hoped that those in a position to do so may be induced to search for the powder and endeavour to make it a commercial article.

Further information required.

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FLEMINGIA congesta. The Arabian Drug Waras or Wars.

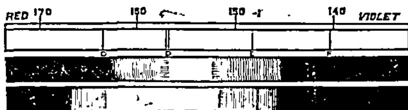
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Further information wanted.

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Editor, Dr. George Watt, Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series; those on Forestry in the Forest Series. Papers of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

This sheet and the title-page may be removed when the subject-matter is filed in its proper place, according to the letter and number shown at the bottom of each page.

NOTICE.

Future issues of this publication placed under either the "Special Veterinary" or "Special Forest Series" will not be included in the annual enumeration. Such papers are printed for Departmental purposes. Their unfortunate inclusion in the system of annual numbering has led recipients of the ordinary issues to think their sets incomplete.

The following pamphlets have already appeared as Special issues, and have not accordingly been furnished to the public.

1894 . . . Nos. 8, 9, 10, 11, 13 and 15.

1896 . . . No. 8.

THE

AGRICULTURAL LEDGER.

1898—No. 17.

IRON.

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. IV., I. 440-71.*]

THE IRON INDUSTRY IN THE CENTRAL PROVINCES.

A memorandum containing extracts from the Reports furnished on the subject by Deputy Commissioners and Forest Officers.

Other DICTIONARY articles that may be consulted:
Iron Oxides, *Vol. IV.*, I. 472-7.



CALCUTTA:
OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING, INDIA.
1898.

Price 2 annas or 2d.

The objects of THE AGRICULTURAL LEDGER are :—

(1) To provide information connected with agriculture or with economic products in a form which will admit of its ready transfer to ledgers;

(2) To secure the maintenance of uniform ledgers (on the plan of the Dictionary) in all offices concerned in agricultural subjects throughout India, so that references to ledger entries made in any report or publication may be readily utilised in all offices where ledgers are kept;

(3) To admit of the circulation, in convenient form, of information on any subject connected with agriculture or economic products to officials or other persons interested therein;

(4) To secure a connection between all papers of interest published on subjects relating to economic products and the official Dictionary of Economic Products. With this object the information published in these Ledgers will uniformly be given under the name and number of the Dictionary article which they more especially amplify. When the subject dealt with has not been taken up in the Dictionary, the position it very possibly would occupy in future issues of that work will be assigned to it.

(Mineral and Metallic Series, No. 12.)

THE AGRICULTURAL LEDGER.

1898—No. 17.

IRON.

[*Dictionary of Economic Products, Vol. IV.*, I. 440-71.]

THE IRON INDUSTRY IN THE CENTRAL PROVINCES.

A memorandum containing extracts from the Reports furnished on the subject by Deputy Commissioners and Forest Officers.

IRON ORES.

The following reports on the Iron Industry of the Central Provinces were received by the Reporter on Economic Products to the Government of India in response to a circular letter soliciting fresh information on the chief minerals of the provinces. The accompanying reports were considered too lengthy for publication in the *Review of Mineral Production in India* for 1897, and are accordingly brought together in the form of an *Agricultural Ledger* since the accounts are not contained in the *Dictionary of Economic Products*:—

Deputy Commissioner, Saugor.

1. *Saugor.*—There are six iron mines in Mauzas Tigoda, Hirapur and Baretha in the Banda tahsil These mines are not leased out but are open to all paying annas 8 for each furnace. The total number of persons employed was 1,844, the total earnings R604 and the total wages paid R211. The details of furnaces are given below —

Name of Village	No. of furnaces.	Annual duty. R	a.	p.
Tigoda	12	6	0	0
Hirapur	15	7	8	0
Baretha	8	4	0	0
	35	17	8	0

Deputy Commissioner, Damoh.

2. *Damoh.*—There are certain blacksmiths, two in number, in Mauza Koopi in the Hatta tahsil, who purchase iron ore at the rate of

IRON.	The Iron Industry

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Damoh.

24 maunds per rupee from Mauza Deora in the Chhattarpur State; they smelt it and extract refined iron and make therefrom utensils, such as pans, *tawas*, etc. Retail purchasers take these to the North-West Provinces for purposes of trade and sell the pans at 3 or 4 seers per rupee and *tawas* at 4 to 6 seers per rupee. The blacksmiths prepare a kiln in the earth, put the iron ore into it and obtain the metal in a superior form. They purchase coal for smelting purposes from villages. They do not pay any Government dues, but the *Malguzar* (landlord) levies a duty of R16 per kiln per annum in lieu of the fuel obtained by them from the Malguzari forest.

Deputy Commissioner, Jabalpur. Conf. p. 8 et seq.

3. *Jabalpur.*—The number of furnaces at work generally in this district on smelting iron ore is 28 for the current year. In previous years the number was fluctuating.

Trade in native iron affected by the European articles.

As a matter of fact the industry is one which is considerably influenced by the European iron which is fashioned to meet all requirements of the market, whereas the native iron produced in the district is sold in lumps as locally prepared, and is very costly to work into shape. The number of persons employed daily from 1st November to 31st May per furnace from the time the furnace is made, to that when the crude iron is turned out, is as follows :—

Labour engaged per furnace.

For cutting wood and converting it into charcoal	7 men.
For extracting the iron ore	2 „
To attend to the furnace	2 „
For refining the iron, Bellows and Hammermen .	4 „
Refiner	1 man.
For making separate charcoal of dry bamboos for refining purpose	5 men.
TOTAL .	21 „

Furnaces are annually worked for about seven months, *i.e.*, from November to May. During the rains no work is done.

Cost of furnace.

(*a*) The cost of making and maintaining a furnace is estimated at R261.

Each furnace when in work consumes daily 3½ maunds of iron ore and 4 maunds of charcoal. The outturn, at the end of the day's work, of crude iron varies from 33 to 50 seers.

Outturn of crude iron.

The estimated outturn of crude iron, called locally "Tickole" or "Bloom," in the seven months' season would be about 275 maunds,

IRON ORES. Jabalpur.

which sells at about R4 per *gon* = 3 maunds = R366-10-8, leaving a profit of R105-10-8. This *bloom* is then re-smelted into pig iron locally called "Chaudia." For this refining purpose 10 men are engaged, these men can refine in one day the crude iron obtained from the furnaces, or about 220 maunds. The cost of the last operation is estimated as follows :—

Cost of refining crude iron.

	R
Labour at R14 per mensem and 1 blacksmith at R8 per mensem, converting 275 maunds bloom iron into pig iron for 2½ months . . .	51
Cost of preparing bamboo charcoal . . .	35
Forest dues on bamboo charcoal . . .	9
TOTAL .	95
Add cost of making bloom	261
TOTAL .	356

Outturn of pig iron.

The outturn of pig iron from 275 maunds bloom is equal to 220 maunds, which, at the average market rate, *viz.*, R2-8-0 per maund, yields R550, or a profit on the whole operation of R194.

The above details refer to the cost of working one furnace. Multiplying them by the number of furnaces working some idea of the extent of the industry may be formed.

Computed extent of the industry.

Roughly estimated, it comes to about R16,000, of which 64·73 per cent. is spent on labour.

The area required to supply the quantity of charcoal noted above is about 30 acres per furnace, *i.e.*, 840 acres in all.

Trade in pig iron. Distribution.

The pig iron so produced finds its way into all the local markets for all agricultural and domestic requirements, and it is even exported for similar purposes to Mirzapur, Ghazipur, Agra, Cawnpur, Lucknow, Benares, Dinapur, Nagpur, Bhusawal, and Khandwa. The famous Olphert's oxide of iron paint is also manufactured in Murwara tahsil, being ground in mills worked by water power. It appears they engage about 50 women and children, and the annual out-turn is about 1,500 maunds, which is exported all over India, at a cost here of R5-8 per maund of 82lb.

Conf. p. 22. Olphert's paint. Labour and outturn.

Divisional Forest Officer, Mandla. Outturn.

Mandla.—There are altogether 51 furnaces. The quantity produced during 1897 amounted to 9 tons. The owners of 18 furnaces in the Dindori tahsil obtain the ore from the Rewah

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IRON ORES. Mandla.

State or other parts of the district. The earnings in 1897 are stated by the people themselves to have been from R25 to R30 per furnace. The people do not depend entirely on iron smelting for their livelihood, but supplement it by agriculture. The famine had a prejudicial effect upon this industry as several iron smelters abandoned their special occupation and took employment as common labourers.

Iron smelters also agriculturists Famine.

Deputy Commissioner. Seoni. Famine.

Seoni.—The industry of iron smelting entirely stopped last year on the outbreak of the famine, the people left their houses and went to labour on relief works or elsewhere.

Divisional Forest Officers. Narsinghpur.

Ore not abundant.

Narsinghpur.—The district of Narsinghpur is not very rich in iron ore, though ore is found in several places, but in small quantities. Tendukhera is the only noteworthy place in the district where the ore is found abundantly, but the mines are on altogether too small a scale to make it worth the while of a company to put any capital into the business.

Decline of the Industry.

Formerly there were 50 furnaces worked by some 40 smelters, now there are only 25 worked by 16 smelters. Some of the men have died and some left this work during the famine, which diminished the demand for iron.

Since English manufactured articles have found their way into the local markets, the trade of Tendukhera iron has fallen off.

Deputy Commissioner. Rate of wages.

In the two mines which are regularly worked, each person employed for digging ore gets six pies for a basketful of ore dug. In this way each labourer earns three to five annas.

Divisional Forest Officer. Chanda.

7. *Chanda.*—The iron ore crystalline hæmatite was quarried from the following localities. During the year 1897 (1) Lohara hill, about 6 miles east of Talodi, on the main road from Mul to Brahmapuri, (2) near Gaujewahi, about 2 miles south-east of the village from hill called "Aswal Dongri," (3) a small hill in the Dewalgaon village lands, about 6 miles of Armori, (4) a hill called Sattighat, about 8 miles east of Wairagarh, (5) hills near *Pariswada* (Sironcha tahsil).

Localities from whence obtained.

Collection and carriage of ore.

The ore was for the most part dug out in big lumps and then broken into convenient sized pieces and stacked in heaps. It was then carted by the *Kotwars* or smelters to their furnaces or *kothees.* The cost of carting the ore varying according to the distance of the village from the quarry.

IRON ORES.
Chanda.
Description of furnaces.

3. It will not be amiss to here explain the kind of furnace used and the method of smelting. No doubt the system employed does not give anything like the outturn that should be obtained from the iron put into the furnaces. There is also a greater waste of fuel than need be. Worked under different principles, the iron industry of the district should be made to pay a good profit instead of the hand-to-mouth business it now is.

The furnaces, locally called *kothees*, are built up chiefly of clay and small stones 6 feet in height, of an irregular conical shape with a projection in front The flue does not run straight down the centre, but slopes down from the top to the opening for the nozzle of the bellows at the bottom.

Process of smelting.

The flue of the furnace is from 12" to 13" across at the top to 6" at the bottom. The entire furnace on the outside, with the exception of the fire hole, is closed. On the furnace being charged with alternate layers of ore and charcoal and the fire put in, the fire hole is closed with bricks and plastered over with wet earth, leaving only a small passage for the nozzle of the bellows to fit into. As the charcoal and iron ore burn, more layers of ore and charcoal are put in. After four hours a small hole is made at the bottom of the furnace for taking out the slag; the hole is then closed. After another four hours the furnace is opened, and the iron which has by this time formed a lump at the bottom is taken out, and in some cases subjected to a second process of smelting in a smaller furnace, whose height is only about 1½ feet. This furnace, besides having the nozzle hole for the bellows, has a hole in front kept open for any slag remaining to run out. This second smelting was not, however, used by all *Kotkars*, and consequently the prices obtained for one smelting were much lower than if a second smelting had been done

A second smelting occasionally resorted to.

During the year 1897 there were 23 furnaces working. These furnaces were worked from January to the end of May, five months in all No working was carried out during the rains.

Numbers of furnaces employed during the year.

The average amount of ore used in the furnaces monthly was about 182 tons to give a yield of 40 tons of rough iron. This would give the total quantity of iron ore quarried at about 910 tons in the district and the yield to smelters after one smelting of 200 tons of iron

For the working of each furnace monthly the *Kotkars* paid a royalty of from R3 to R5. This royalty enabled the *Kotkars* to remove

Royalty paid to the Forest Department.

IRON ORES. Raipur. Number of furnaces at work. Difficulty of ascertaining quantity of ore treated. Profits.

per furnace. Thus the total estimated expenditure per furnace is about R361. They use as much iron ore as they can take out from the quarries throughout the year and there are no data to find out exactly what quantity is used in each furnace during a year. The approximate quantity as far as could be ascertained is in round figures 8$\frac{4}{7}$ tons. Each furnace produces about 2$\frac{1}{7}$ tons of smelted iron, which is wrought and sold at the rate of four seers per rupee. Thus the gross income from each furnace is nearly R550 per year. The net income after deducting the cost of quarrying, charcoal and royalty is consequently R189 per furnace per year.

Jabalpur. *Conf. pp 2, 3.*

IRON INDUSTRY IN THE JABALPUR DISTRICT.

Copy of letter, dated the 14th February 1898, from R. S. Hole, Esq., *Assistant Conservator of Forests, to the Conservator of Forests, Northern Circle, Central Provinces.*

Iron smelting distinguished from iron manufacture.

Under the general term of iron industry two main branches of employment are included, the object of one being the smelting of the iron and the production of workable metal from the crude ore, and of the other the production of articles manufactured from the metal. It is necessary to draw a distinction between them as the class of people engaged in the two cases is quite different.

Iron smelters.

2. The actual smelters or *bhatti-wallas*, as they are generally called, are invariably poor, low caste individuals, such as Dhimars, Lohdis, Kachchis, Patharis, Chamars, Gonds, etc., and are very rarely Lohars, *i.e.*, workers in iron, or blacksmiths by caste. A good experienced smith can easily earn from R15 to R20 a month and sometimes more, so that there is obviously very little inducement for him to take up iron smelting at a maximum wage of R8 per month. The present smelters are, without exception, an ignorant class of people, very poor, absolutely unambitious and blind to their own interests They seem to be quite content as long as they can manage to exist and any course of action, however advantageous in the long run, which involves a little present trouble and exertion is not contemplated by them. Like most natives they are strongly imbued with conservative ideas, and as long as possible they stay in the old groove in which their fathers ran, and when that becomes absolutely impossible and not before, they make shift, as best they can, to live with the least possible exertion. Such men are eminently unsuited to be leaders of industrial progress and they, to

Their want of enterprise. And hence gloomy prospect of the industry.

IRON ORES.
Jabalpur.

whom one would naturally look to develop the industry, are most to be blamed for its moribund condition. It is true that they have for many years been subjected to the tyranny of the middlemen, as well as confronted by other difficulties, but, at the same time, they have generally only had themselves to blame for this. The poverty of the smelters makes a middleman a necessity, and as the smelters seem to regard their poverty as inevitable, as, with their present character, it certainly is, they look on a lessee as the only person who can give them employment and therefore a blessing. At the same time, the lessee who is generally a Malguzar or other non-resident proprietor, not being a Lohar, does not see his way to increase his gains by developing the industry and improving the furnace and plant, but confines himself to working the smelters as hard as possible with minimum pay, thus making it their interest to do as little as they possibly can for the money. The Lohars or black-smiths, *i.e.*, men who usually confine themselves to manufacturing articles from the iron prepared by the smelters, are generally much more intelligent. They prefer to be quite independent so that they can mend tools and pick up other odd jobs when not engaged on carrying out orders. They can, moreover, turn out articles of good workmanship, many of them requiring considerable skill. I have seen a rifle barrel made some 15 years ago at Barela from Bagharaji iron which is wonderfully true and symmetrical. Inside it is octagonal in shape which probably gives a spin to the bullet similar to straight rifling. The whole rifle was of native make and sold for R35. Most of these smiths know nothing of the process of iron-smelting or of the construction of the furnace and, as a rule, only those Lohars who are not clever enough to make their living as smiths become *bhatti-wallas*. There can, however, be very little doubt that the shape and size of the furnace and general methods employed by the smelters are probably the very best that, with the simple appliances at their disposal, they could possibly adopt, but it is very doubtful whether people of the present class of smelters could have originated or have improved any such method. That the early smelters and smiths of India were skilful men seems well established, inasmuch as they were able to produce a mass of wrought iron in the fourth century which would have been no easy operation at the present day with our largest rolls and steam hammers, and how it is that "this

Lessees.

Lohars or blacksmiths.

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IRON ORES. Jabalpur. Smelters.

furnaces in work during any year do not in any way indicate the true state of the industry at the time, and conclusions drawn from them as to the relative prosperity of the industry at various times are erroneous. To make this quite clear, a very brief sketch of the history of the industry here during the last few years may be given.

History of the industry.

4. In 1885, when the first effort was made to revive the industry, it was believed that the baneful influence of the middleman was the principal cause of the miserable state of the smelters, and, in consequence, it was decided (in the words used at the time by the Commissioner) " to let native iron smelters take out a license from Government direct at a fair rate, while licenses should be renewable annually at the same rate for a period of say 10 years or longer if thought necessary." " This would give these men the security which at present, it is said, they have not and would encourage them, if anything is likely to, to improve their furnaces and plant." At the same time the high octroi duty and excessive taxation to which they had been subjected were reduced. Whether these measures resulted in the construction and working of a larger number of furnaces is not evident, but certainly no improvements were made in the furnaces or plant. In a report made by Mr. Bose (of the Geological Survey of India) on the subject in 1888, the following remark occurs:—" These men are too ignorant to properly understand their own interests," and he gives as an example of their stupidity that when one year Mr. Olpherts gave a large order for all the refined iron smelted in the furnaces on the Lora Range, they were very pleased at having cheated his agent by giving him the rough bloomery iron with about 30 per cent. of slag instead of the refined iron. At the same time, the smelters complained of the trouble necessary to get a license direct from Government, and said they preferred getting it from a lessee, who, three years before, had been cited by the Deputy Commissioner as the greatest curse of the industry, inasmuch as he was able by refusing a license " to throw out of employment the resident Lohars (*i.e.*, smelters) or to compel them to betake themselves to other localities."

Government assists the smelters.

Did not result in improvement of furnaces or plant.

These remarks may seem to be unnecessary, but I have considered them worthy of mention since they show that what has happened again in the last few years is practically a repetition of what took place several years ago. In 1894 the Industry had apparently

IRON ORES. Jabalpur. Smelters. Position of the industry in 1894

once more sunk to its own level, and from 1894 to 1896 efforts were again made to revive it. This time the course of action was to hand over all the more important mines to the Forest Department to prevent "the Lohars (smelters presumably) being crushed by the heavy royalties imposed by middlemen," and a royalty of R50 for wood and R10 for ore for one furnace, for a whole season, was fixed for all the furnaces which obtained their wood from Government forests. For the first year only R50 was charged, the royalty on the ore being remitted. Arrangements were also made that coupés should always be open within easy distance of the furnaces. At first the number of furnaces rapidly increased, and in 1895 there were probably more than 60 furnaces in work. Then came the famine, and the demand for the articles usually made from the Indian iron decreased, the iron could not be sold and the smelters had to stop work. *Then help came in the shape of money advances from Gov*ernment, and a number of smelters again started work with the result that a considerable quantity of iron was manufactured which could not be sold. A certain amount of it was eventually disposed of by manufacturing tools for the relief works, but a great deal was still left on the market. Consequently, the number of furnaces is now again decreasing, and the industry returning to its normal state of stagnation. It is true that the advances were generally given to the lessee or middleman (notably to the Malguzar of Sunawal who had 15 furnaces under him), but it is very probable that, if the money had been given direct to the smelters, such as they now are, the final results would have been much the same. As a relief work, the money advances no doubt did a great deal of good in keeping the smelters at their customary congenial occupation, instead of allowing them to burden the Government works, but, as far as improving or reviving the industry went, this policy was absolutely useless. To deal primarily with the middleman who naturally puts his own interest in the fore-ground and on whom the smelters are more or less dependent is an obvious mistake, and to increase the outturn of iron, without reducing the labour or improving the methods by which it is produced and so reducing its market price, can only end in drugging the market and in throwing the smelters eventually out of work.

Forest Department.

Royalty.

Number of furnaces working in 1895.

Famine.

Present decline of the industry.

5. At its present prices, there is a very limited demand for the Indian iron, but, such as it is, it seems fairly constant, so that,

Limited but steady demand for Indian iron.

IRON ORES.
Jabalpur.
Smelters.

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IRON ORES. Jabalpur. Steel, (Continued)

facing tools. The Indian iron is sold in round cakes, about 6" in diameter, 1" thick and weighing $4\frac{1}{2}$ seers, at about R3 per maund. The *kheri* is, as a rule, more expensive and sometimes fetches as much as R$3\frac{1}{2}$ per maund. Most of the English iron used is old iron generally bought from the railway at R2 to R2-8 a maund, consisting of old rails, screws, nuts, broken wheels, axes, etc., out of which the ordinary heavy hammers and other common articles not requiring much shaping are made. English iron is bought in flat bars at R5, in wires or small square bars at R6, as steel at R6 to R8 or as best steel at R10 a maund. The latter is largely used for the sides of tongas.

English scrap iron.

6. The ores which have been most largely worked during the past year are of three principal types :—

Kinds of ore worked.

(*a*) That used by the furnaces at Borha, Sonti, Tonri, Bagharaji, Kundwara and Sunawal which is chiefly obtained from the mine at Partabpur, but also from shallow excavations at many other places in the neighbourhood, especially at Agaria. The ore is "a soft, crumbly, fine laminated micaceous iron, with some interbanded argillaceous layers." "The rock is so soft that it can be powdered between the fingers, and is simply dug out with ordinary *kodalis*." Below this there is generally "a schistose hæmatite, which is harder than the micaceous iron, although easily worked on account of its fissile character."

The schistose hæmatite yielded on analysis 68 per cent. of iron, and the soft ore from Partabpur gave 65 per cent., both containing a little phosphorus and sulphur. The soft, crumbly ore is very splendent, dark grey to black in colour, with a distinct cherry-red streak.

Result of analysis.

(*b*) That found near Dhanwahi, Mangeli and Gogra on the Lora hills, used last year in the furnaces at Hargarh and from which the *kheri* is made. This ore is a "manganiferous micaceous hæmatite containing a varying proportion of interbanded jaspery quartz." "It is a siliceous ore, although not very highly so." An average sample of this gave 46 per cent. of iron and 12 per cent. manganese with traces of cobalt. "The manganese exists, in large part at least, in the form of psilomelane, occurring in irregular segregations, or more minutely disseminated through the rock." The

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IRON ORES. Jabalpur Kinds of ore worked.

present pits "are only in talus not in the rock *in situ*," the lumps of ore being embedded in reddish clay. The colour of the ore varies according to the proportion of manganese, but it is less lustrous and more bluish-grey in colour than the Partabpur ore also with a less distinct red streak.

(*c*) The lateritic ores which prevail in the north of the district and were used last year in a few furnaces in the Murwara tahsil, *e.g.*, the four furnaces at Khaireni. The principal ores are two varieties of pisolitic limonite, "one of which breaks with a smooth conchoidal fracture and shining surface; the other with a rough uneven fracture and dull lustreless surface." "In the former the hardness and tenacity of the spherules, and of the cement in which they are embedded, are about equal, so that fracture takes indifferently through both parts of the rock." "The difference of fracture in the other variety is due partly to the cement, and also the spherules, breaking with a dull uneven surface; partly to some of the spherules being dragged out of their sockets unbroken, so that the surface of the rock shows a number of rounded prominences and depressions." "The conchoidal-fractured limonite is hard and brittle, the other much softer and sometimes quite friable." These varieties, however, seem to pass insensibly the one into the other, the hardness and tenacity of the spherules and of the cement often varying in the same piece of rock, so that the fracture in one place is smooth and conchoidal, while in another it is dull and uneven, many of the spherules having been dragged out of their sockets unbroken. These ores contain from 50 to 57 per cent. of iron and "a much higher percentage of phosphorus than the hæmatites, the phosphoric acid in the latter ranging from ·10 to ·27 per cent., and in the former from ·76 to 1·41 per cent.

Percentage of iron.

7. The primitive methods and simple appliances, now used by the natives to smelt the iron here, are probably the same as have been employed by them from time immemorial and are shortly as follows:—

Description of furnace.

The furnace employed is probably the simplest form of the iron furnace now to be found in the world. It is built entirely of clay and sun-dried bricks. From behind, the furnace appears as a semicircular erection rising 3' above the level of the ground. In front a trench is dug to a depth of 3', 3' 6" wide at the bottom, 4' wide at the

IRON ORES, Jabalpur. Description of furnace.

top and about 11' long. From the bottom of this trench to the front of the hearth of the furnace is 1' and the hearth which slopes up towards the back of the furnace is about 2' × 1' 10". From the front of the hearth (the back of the hearth being 5" higher) to the throat of the furnace is 4' 10" and at the throat the shaft is 10" square. The side walls are 10" to 12" thick and the hind wall 16" to 18", these being constructed of sun-dried bricks overlaid with a mixture of two parts of clay and one part *kodo* straw. These slope slightly outwards from the top of the furnace towards the ground. The front wall is only 2" thick, and in this there are no bricks. The bottom of this front wall is 1' 1" above the front of the hearth and slopes slightly outwards towards the top of the furnace. This front wall has to bear most of the pressure of the burden, and as it is only supported by its adhesion to the thick side walls, it must, at the same time, be kept thin. As a general rule, therefore, it only lasts about eight days and then has to be replaced. The top of the furnace is covered in by a light clay roof about 1½" thick, the large hole about 6" square being left open.

The man who plies the bellows sits in the trench in front of the furnace and, to prevent the smoke and ashes blowing from the charge-hole (which also acts as the chimney) into his face, a thin screen of clay 1" to 1½" thick is erected on the top of the furnace, 3' high in front and 2' 6" at the sides. In front of the furnace a roof of branches and leaves, supported on four posts, is placed as a shade from the sun. The whole furnace takes from 10 to 20 days and sometimes longer to prepare, costing about R8 As it is built of clay, it has to be constructed in sections, each of which must be left to get thoroughly dry, to allow the clay to consolidate, before the work is continued and so the construction of the furnace is necessarily a matter of some time. The usual arrangement is that nothing is paid for actually making the furnace. A lessee having engaged a *bhatti-walla* for the season at R7 to R8 per month, the latter sets to work to construct the furnace, he and his family devoting three or four hours to the work every three or four days, letting it get dry in the interval. As their usual occupations, therefore, are very slightly interrupted, the smelter gets nothing for this and is only paid after the furnace is finished and in work. On the front of the hearth a *gaderi* is placed which looks like a long, curved brick made of

Cost of constructing furnace.

Methods followed and appliances used.

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Jabalpur.

Methods followed and appliances used.

sun-dried clay, about 2' long, 2" thick and 5" broad. In this about 20 holes are bored, the centre upper one not being perforated. In the latter a stick is placed which, resting on the bottom of the trench, supports the *gaderi* in its place. The bottom of the furnace is then filled with a mixture of charcoal and cow-dung, about 7 seers of the former and 5 of the latter, to the level of the top of the *gaderi*. On the top of the *gaderi*, equidistant from the sides of the furnace and from each other, kept pressed against the bottom of the front wall of the furnace by two stones resting on the *gaderi*, are two tuyères or *badlais*. These are directed so as to converge at the back of the furnace. They are made of sun-dried clay, about 1' 9" long, the diameter of the aperture at the large end being 2" and at the small end ¾", the outside diameter being 4" and 2" respectively. The whole of the front of the furnace from the front of the hearth to the bottom of the front wall, is then closed up with clay, leaving the apertures of the two tuyères of course uncovered. On the side of the trench opposite the furnace a step is cut, and resting on this and on a pole placed in two forked sticks leaning against the side of the furnace, are two or three flat boards, the end of the boards coming just below the apertures of the tuyères, so that the blower who sits here can comfortably ply the bellows. The bellows are made of goats' skins, about 1' in diameter and from 2' to 2½' high when stretched. They cost about R12 and last a whole season. The whole furnace is then filled with charcoal from the charge-hole, about six large baskets being necessary, or about 42 seers. The furnace is then fired by blowing live charcoal through the tuyères and the whole is speedily in blast. When the furnace is thoroughly heated and the charcoal sufficiently sunk for the purpose, a basket of ore (this is circular, 9" in diameter and 6" high, holding about 9 seers of ore), and a basket of charcoal (this basket is also circular, 1'6" in diameter and 11" high, holding about 7 seers of charcoal) are added through the charge-hole. This is then done at regular intervals of 40 minutes, during the 12 to 14 hours that the furnace is in blast, in all 20 baskets of ore and 20 baskets of charcoal being used. Thus, altogether, 189 seers of charcoal (4 maunds 29 seers) and 180 seers of ore (4½ maunds) are used. Periodically at intervals of 30 or 40 minutes, a hole in the *gaderi* is opened with an iron poker and the slag allowed to run out, while the iron remains behind as a

Tuyeres.

Bellows.

I. 440-71.

pasty mass. As the work continues the tuyères are gradually burnt away until, at last, only about 3" to 4" are left. No flux is used, so that the slag is highly ferruginous, the silicon in the iron being oxidised and forming with a portion of the iron a fusible ferrous silicate. Not only, therefore, is a portion of the metal wasted in the slag, but it also seems certain that the removal of the silica cannot be so complete, as it would be with the adoption of a suitable flux, and so extra labour is required to refine the resulting iron from the impurities still contained in it. After continuous working for 12 to 14 hours a porous bloom of iron is obtained weighing 30 to 35 seers, about 1' 9" × 1' 4" × 5" in size. The *gaderi* is then dug out with a pick, the iron pulled out while hot into the trench and left there during the night to cool until the next morning. If this rough bloom of iron is then sold, as it is, it fetches from R1-2-0 to R2, but it is generally first refined.

IRON ORES. **Jabalpur.** **Methods followed and appliances used.** **No flux employed.** **Consequent waste of metal.**

8. The iron is refined as follows:—

Refining process.

The rough bloom having been broken into two pieces, these are taken away to an ordinary blacksmith's forge and heated to a red heat in a small furnace about 1' 6" high and 10" to 12" square It is then beaten by heavy hammers on an anvil and formed into round cakes, in which form it is usually sold at R2-8 to R3 per maund. From 20 to 30 per cent. of slag separates out from the iron in this process. An experiment made by Mr. Bose, with the *kheri* obtained from the manganiferous ore of Dhanwahi, showed that the rough iron lost as much as 38 per cent. of slag in the refining, while a later experiment with the Partabpur ore gave a loss of only 24 per cent. From 45 to 55 seers of charcoal are used daily in the refining furnace and it is worthy of remark that, whereas any wood is used indiscriminately for the charcoal employed in the smelting furnace, charcoal made from dead bamboos is exclusively used for the refining furnace. The bellows, also, in this case are smaller, being about 1½' high when stretched and costing about R5.

9. With regard to the number of persons employed in the industry, the following remarks are given:—

Labour employed.

(*a*) *For preparing charcoal.*—The usual charge for the supply of charcoal for one smelting furnace is from 8 to 12 annas a day.

IRON.	The Iron Industry

IRON ORES.
Jabalpur.

eight people being usually employed in cutting the wood and preparing the charcoal at the following rates per day:—

Charcoal burners.

A skilled man	2 annas.
An ordinary man	1½ "
A woman } A child }	1 anna.

The people employed in this work are usually Kols, and it is found necessary to give advances to those people or else they cannot be depended on to perform the work, or prevented from working for other people. From six to eight people are, on an average, employed in preparing the charcoal for the refining furnace.

Miners.

(*b*) *For digging out and bringing the ore to the furnace.*—As a rule one man and his family, or from two to three individuals are employed on this work and the amount paid varies, according to the difficulty of getting the ore, the distance to which it has to be transported and the state of the road. Six rupees is paid at Tonri for the ore required for one furnace during a month, the ore being the soft, powdery, micaceous iron very easily extracted from the Partabpur mine about 5 miles off, whereas at Sunawal R7 is paid for the same ore, although the distance is nearly the same. At Dhanwahi and Gogra the charge is two annas a day for the ore extracted from the mines close by, whereas it is R0-2-9 for the furnaces at Korala and Hutwar, respectively 5 and 7 miles from the mines. This charge also includes *dressing*, *i.e.*, breaking up the ore into small bits and roughly separating it from the quartzite matrix, which operation is unnecessary in the case of the Partabpur ore. The ore is carried on pack buffaloes.

Charges for collecting the ore.

Smelters

(*c*) *For managing the furnace.*—Two men are employed. One is the overseer who builds the furnace and understands the business of smelting thoroughly, getting from R7 to R8 a month. The other man, who simply acts as blower, gets R4 a month. These two men ply the bellows alternately, the one not engaged on the bellows seeing that the furnace is kept properly charged. A non-resident proprietor has to employ a munshi to supervise the smelters, the Malguzar of Sunawal employing three munshis, each on R10 a month, to supervise twelve furnaces and to keep the accounts.

(*d*) *For refining the iron.*—As a rule eight persons are required: the Lohar who superintends the work and holds the iron on the

anvil and directs the beaters or hammermen, getting from R10 to R15 per month, five hammermen and two men to work the bellows, on daily labour at $1\frac{1}{2}$ to 2 annas a day. These people usually work from 5 A.M. to 1 P.M., the blower working $3\frac{1}{2}$ hours on end and then changing. They can refine in one day from 90 to 105 seers of rough iron, or the produce of three furnaces, making from 60 to 70 seers of refined iron.

IRON ORES. Jabalpur. Labour necessary for refining. Wages.

(e) *For manufacturing articles from the iron made.*—As a rule, one Lohar or experienced smith is required, three to four beaters or hammermen, and one woman for the bellows. The beaters and woman who works the bellows are employed at $1\frac{1}{2}$ to 2 annas a day and the usual arrangement is that, when any person desires certain articles, he gives the refined iron to the smith who then makes the articles required at the regular rate of R4 per maund, in other words, a maund of manufactured articles is made at a cost of R4. The working hours are usually from 6 A.M. to 6 P.M with a break from 12 A.M. to 2 P.M.

Blacksmith and assistants.

For making certain articles more hammermen are required than for others, thus for *gantis, kulharis, kodalis*, and *phaoras* four hammermen are required and otherwise only three are employed. For some articles which require a good deal of finishing such as *karahis*, an extra man is employed who gets 4 to 5 annas a day, being able to make four or five finished *karahis* in one day from the rough plates prepared by the beaters.

As I have before remarked, most of the smiths have now betaken themselves to the larger towns and carry on their trade chiefly with English iron, only taking small quantities of Indian iron now and then, according to the demand.

Conf. p. 10.

10. The commonest articles made from the native iron are the following:—

Manufactures from native iron. Conf. p. 23, et seq.

Gantis, pickaxes.
Hansiyas, sickles.
Kulharis, axes.
Pans, plough share.
Kodali, a pickaxe with one tooth.
Phaora, a kind of spade.
Karrahi, large plate with handles.

IRON.	The Iron Industry

IRON ORES.
Jabalpur.
Metallic paint.

Nails and hammers of various kinds are also made and occasionally gun-barrels (especially at Barela). I have also heard that small swords are still made in places, but I have as yet seen none.

Conf. p. 3, also Dict. Econ. Products, Vol. IV. p. 521.

11. Before closing this report on the iron industry of the district, it is worthy of notice that Mr. W. G. Olpherts has found a subsidiary use for the local iron ores which he has now practised for many years, *viz.*, the manufacture of his well known metallic paint. This gentleman held a lease of the iron mines at and near Jauli and Sarroli from 1875 to 1890, the principal ore which he used being that from the Jauli mine. This is described as "a semi-ochreous hæmatite in which a slightly schistose structure is often apparent. Hæmatite with metallic lustre also occurs, but is quite subordinate to the more ochrey kind. The ore is interbanded with quartzose layers which in some places greatly exceed the ferruginous part of the rock." Picked samples of the ochrey hæmatite are used by Mr. Olpherts, an analysis of which gave as much as 69 per cent of iron while an average sample gave 53 per cent. of iron. The ore is first pounded with crushers, sifted and then ground to an impalpable powder with heavy millstones. In the neighbourhood of the works, the river Kutna has been dammed up by a weir, and arranged along this, there are eight millstones, four of which are larger than the rest. Each stone is fixed to a vertical iron shaft, in the lower part of which stout pieces of wood are fixed which radiate from the shaft like the spokes of a wheel When the water is turned on to those spokes, the shaft revolves and the stone fixed to it turns upon another flat, horizontal stone below it, thus grinding up the ore which, when mixed with water, is poured into a hole in the centre of the upper stone, finally running out into a trough below it. After the ore has been ground up under the light stones, it is passed under the heavy ones; it is then collected and spread out in a layer about 3" thick on smooth flags or a concrete floor where it is left to dry. When quite dry it is powdered up, placed in bags of 1 cwt. and ½ cwt. and sold at R7 per cwt. By mixing the ore with "varying proportions of red lead a series of bright crimson lakes may be prepared, with white lead a variety of lilac colours, with lamp-black and small quantities of the oxide warm chocolate browns may be obtained."

IRON ORES. Jabalpur.

Metallic paint.

To prepare the paint the following constuituents are used in the given proportion:—

Of Olpherts' paint (*i.e.*, dry powdered ore)	14 lbs.
Resin finely ground	4 „
Raw linseed oil pure	20 „
Turpentine oil	¾ „
Verdigris finely ground	½ „

and the following directions are given:—

"First take of linseed oil and paint sufficient quantities so as to macerate in a mortar to a fine paste free from granules. Boil remaining quantity of the linseed oil, in a separate iron pot, to boiling heat; add the quantity of resin to it and boil both over till the mixture nearly attains to a flaming heat. and add the verdigris and the macerated paint and stir the whole briskly until well assimilated and strain all into another clean vessel. The paint is then ready for use—the turpentine oil only being added when the paint is required to be applied at once to anything." Mr. Olpherts now holds a lease of the Gosulpur manganese mine at R1,000 per year, for five years from January 1895, and the pyrolusite from this mine is exported in the form of an impalpable powder, being ground up precisely like the hæmatite, as above described.

Copy of letter dated the 28th February 1898, from R. S. Hole, Esq., *Assistant Conservator of Forests, to the Conservator of Forests, Northern Circle, Central Provinces.*

Native-made iron manufactures. *Conf. p. 21.*

With regard to the number and value of tools manufactured from native-made iron in the Jabalpur District last year and supplied to famine relief works, as well as with reference to the approximate number of individuals relieved by the money advances given by Government, I have the honour to submit the following:—

1. Towards the end of 1896, owing to the famine and the consequent decrease in the demand for articles usually manufactured from the native-made iron, there was a large quantity of the latter upon the market which could not be sold. It was found impossible to get rid of this until the idea was started of making tools for the famine works from this iron. Advances were then given by Government to enable the poorer smiths in the neighbourhood of the principal mines and smelting centres in the district, at Bagharaji and Sunawal, to set up their plant and start work. As these smiths, also,

IRON.	The Iron Industry

IRON ORES. Jabalpur. Native-made iron manufactures.

(*b*) Now with regard to refining the iron and making articles from it. We may first of all assume that all the iron made in the above-mentioned furnaces was refined and rendered marketable, so that the number of persons employed on this refining will be approximately as follows, since eight persons (one Lohar, five beaters, and two blowers) can refine the produce of three furnaces in one day and, on an average, seven persons can supply them with charcoal:—

In January	17 furnaces employed	45+39=84 persons.
,, February	18 ,, ,,	48+42=90 ,,
,, March	18 ,, ,,	48+42=90 ,,
,, April	26 ,, ,,	69+60=129 ,,
,, May	23 ,, ,,	61+53=114 ,,
,, June	4 ,, ,,	11+10=21 ,,
,, July		
,, August		
,, September		
,, October		
,, November	12 ,, ,,	32+28=60 ,,
,, December	12 ,, ,,	32+28=60 ,,

Now from January to June, altogether 833 maunds of tools had been manufactured, and as, on an average, it takes one Lohar, four beaters, and one blower, one day, to produce 19 seers of these ordinary rough tools and seven persons to make the charcoal, it follows that, during these six months, about $\frac{833 \times 40}{150 \times 19} \times 6 = 58$ persons were employed, or more probably, every month 10 Lohars, 40 beaters and 10 blowers, or, altogether *60* persons were occupied and to supply them with charcoal *70* more persons. Finally, at the end of June, altogether about 15,177 seers of refined iron were in stock, and the 12 furnaces, working during November and December, probably produced 12 × 33 × 26* × 2 seers of rough iron, *i.e.*, 20,592 seers, which would give about 14,414 seers of refined iron, allowing for the slag and other impurities. Thus 15,177 + 14,414 = 29,591 seers of refined iron remain to be accounted for. Now, assuming that this is worked up, which would, if so, be mostly made into karrahis, tawas, kulharis, and other articles most commonly used, some of which, especially the karrahi, require more finish than the rough tools made for the relief works, we should have the following additional number of Lohars and assistants employed. On an average one Lohar, four beaters and one blower can produce 17 seers of these

* It is assumed that each furnace is working 26 days in each month to allow for repairs to furnace and other interruptions.

IRON ORE
Jabalpur
Native manufactures.

articles in one day. The refined iron, also, when made up into articles, loses about 38 per cent. of its original volume and weight, so that between July and October, about 9,410 seers of articles and, from November to December, about 8,937 seers of articles were made. During July to October, therefore, $\frac{9410}{17\times120}\times 6 = 28$ persons were employed. We may, with more probability, put this at 30, *viz.*, 5 smiths, 20 beaters and 5 blowers and 35 persons for charcoal. During November to December about $\frac{8937}{17\times60}\times 6 = 53$ persons were employed. We may, with more probability, put this at 54, *i.e.*, 9 smiths, 36 beaters and 9 blowers and 63 persons for charcoal. It must be observed, however, that a good deal of this refined iron was probably sold and sent to Jabalpur as such and was there worked up into articles and, as the Jabalpur smiths are generally carrying on a flourishing industry just now and by no means entirely depend on the native-made iron for the success of their industry, being able to generally replace it with cheaper English iron, they cannot be said to have depended on the advances and thus to have been relieved. For the present this consideration may be disregarded, and we then have the following figures as the total number of persons relieved last year :—

Month.	Persons employed in			Total.	Approximate number of families.
	Smelting.	Refining.	Making articles.		
January	204	84	130	418	105
February	216	90	130	436	109
March	216	90	130	436	109
April	312	129	130	571	143
May	276	114	130	520	130
June	48	21	130	199	50
July	...	..	65	65	16
August	...	...	65	65	16
September	...	...	65	65	16
October	...	..	65	65	16
November	144	60	117	321	80
December	144	60	117	321	80
Total	...	...	...	3,482	870

Thus an average number of about 290 persons, corresponding to about 73 families, were relieved each month throughout the year.

I. 440-71.

G. I. C. P. O.—No. 393 R. & A.—11-1-93.—2,225.—G. R.

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Editor, Dr. George Watt, Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series, those on Forestry in the Forest Series. Papers of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series.

This sheet and the title-page may be removed when the subject-matter is filed in its proper place, according to the letter and number shown at the bottom of each page.

NOTICE.

Future issues of this publication placed under either the "Special Veterinary" or "Special Forest Series" will not be included in the annual enumeration. Such papers are printed for Departmental purposes. Their unfortunate inclusion in the system of annual numbering has led recipients of the ordinary issues to think their sets incomplete.

The following pamphlets have already appeared as Special issues, and have not accordingly been furnished to the public :—

1894	. .	Nos. 8, 9, 10, 11, 13 and 15.
1896	. .	No. 8.

THE

AGRICULTURAL LEDGER.

1898.

OXEN.

(CATTLE DISEASES.)

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. V., O. 590-94.*]

RINDERPEST.

Further report, on Experiments with Rinderpest, by VETERINARY-CAPTAIN F. RAYMOND, F.R.C.V.S., *Superintendent, C. V. D., Bengal.*

Consult

Agricultural Ledger No. 5 of 1898.



CALCUTTA:
OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING, INDIA.
1898.

Price 2 annas or 2d.

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(Special Veterinary Series, No. 6.)

THE
AGRICULTURAL LEDGER.

1898.

OXEN.

(CATTLE DISEASES)

[*Dictionary of Economic Products, Vol. V.*, O. 590 94.]

RINDERPEST.

Further report, on Experiments with Rinderpest, by VETERINARY-CAPTAI[N]
F. RAYMOND, F.R.C.V.S, *Superintendent, C. V. D., Bengal.*

1. In the last report submitted in September 1897, it was stated that a number of cattle (107) had been inoculated against Rinderpest at Kanti near Muzaffarpur.

107 cattl[e] inoculated Septemb[er] 1897 stil[l] immune

2. Although Rinderpest existed then, and has since appeared in the immediate neighbourhood of the herd, none of the 107 animals have showed any sign of infection, with the exception of certain experimental cases details of which are given later.

Conf. Agricultural Ledger No. [?] 1898, pp. [?] 46.

3. On the 7th January 1898 a telegraphic report reached me of the appearance of Rinderpest in the village Harsair, near the out-work of Raghai, near Kanti. I proceeded there and found that typical Rinderpest was raging. Mr. Toomey requested me to inoculate his cattle that were on the out-work, but the usual difficulty arose as to obtaining a sufficient and suitable supply of material. It was, therefore, arranged that a small experimental station should be erected where material could be prepared, and some further experiments carried out. The place selected was isolated and exceedingly bleak at night, but warm in the day, and situated on the banks of Little Gunduk. There was practically no shelter, and the weather during the experiments was cyclonic.

Fresh ou[t]break at Harsair.

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4. I mention these facts because I think they affected the experiments *to a certain extent.* A bamboo enclosure was arranged, and a chowkidar appointed. The attendants were all isolated during the experiments.

5. On the 17th January 8 young buffaloes were infected with material from a typical case of Rinderpest. On the night of the 28th January there was a very bad hailstorm, and the exposure expedited the death of one buffalo calf, No. III, which died on the morning of the 27th, the bile of which was rejected. On this day also buffalo No. IV was destroyed in a dying condition. Bile taken from this one was found to be good.

6. On the 28th the bile from buffalo No. IV was injected into 23 bullocks at Raghai and these were branded "K". On this day also buffalo No. I was destroyed, bile was taken, found good and used to inject 13 bullocks at Raghai. They were branded "T".

7. On the 29th buffalo No. V was destroyed. The bile taken from this animal was found to be good.

8. On the 30th buffaloes Nos. VI and VII were destroyed. Bile was taken from both animals, but that from No. VII was rejected. On this day bile from buffalo No. V was injected into 35 bullocks, branded "$\frac{K}{I}$," and that from buffalo No. VI was used for 26 bullocks, branded "$\frac{T}{I}$".

9. On the 4th February buffaloes Nos. II and VIII were destroyed, the bile was taken and found to be good. The bile from No. VIII was used for 25 bullocks, branded "$\frac{K}{T}$," on the same day the bile from No. II was used for 28 buffaloes, branded "X".

10. Besides the animals enumerated, material was procured from buffalo marked A 1, which was affected with Rinderpest. This was found to be good and was, therefore, used for four bullocks at Nuriar, branded "Z". A 1 supplied a large quantity of bile, but only 4 bullocks remained for treatment.

11. It will thus be seen that 107 bullocks were inoculated in the first experiment, and 126 bullocks and 28 buffaloes were inoculated in the second. The total number of cattle immunised has been 261.

12. Close observation, which has been maintained since the beginning of the work in August, down to the present, has failed to

KANTI EXPERIMENTS.

show any sign of Rinderpest in the animals treated, notwithstanding the fact that the disease has existed in the neighbouring villages for some time.

To test if still effective for inoculation.

13. I have carried out a series of experiments in order to ascertain whether the animals immunised in August and September 1897 were still immune in January 1898.

Conf Agricultural Ledger No 5, 1898, pp 46-47.

14. By a reference to my report of 11th October 1897 and appendices, it will be seen that certain animals were first inoculated with bile, and later with virulent blood.

15. On the 28th of January some of these animals were collected at the experimental station and tied up amongst buffaloes Nos. 1-8 that had become infected with Rinderpest. These bullocks were fed with the buffaloes, and the *post-mortem* examination of the buffaloes as they died, or were destroyed, were conducted as it were under their noses. Moreover, virulent material from the sick buffaloes was rubbed on to the bullocks' muzzles, and each bullock received subcutaneously 1 c. cm. of virulent blood from buffalo No I on the 28th January, and another 1 c. cm of a mixture of virulent blood from buffaloes Nos. II and VII on the 4th February 1898 (*vide* App. I.).

Subsequently it was decided to enlarge the experiment, and 4 more bullocks were placed in the experimental enclosure. These animals had been inoculated with bile only in the experiments of 5th, 6th and 7th September 1897. The details are appended.

Conf. Appendix p 9.

16 These four animals were treated in the same way as the other bullocks with this exception, that they received only one injection of 1 c cm. of a mixture of virulent blood from buffaloes A 1 and A 11 on the 12th February 1897. The details of these experiments are tabulated and appended.

17. The result of the tests has been that none of the animals showed any outward signs of Rinderpest. The temperature of K 4 rose $\frac{4}{5}$ of a degree F. on the 6th day. The temperature of K v rose from 102 degrees to 103·4 degrees on the 6th day.

Resumé.

18. It will, therefore, be seen that altogether 261 head of cattle have been inoculated with the buffaloes' bile, and that up to date none of them have shown any of the outward signs of Rinderpest, though the disease then existed, and has since reappeared in the neighbourhood. Many of the cattle went to work the next day without inconvenience.

KANTI EXPERIMENTS.

19. Seven animals that had received bile in September were re-tested under conditions far more stringent than any animals are likely to be submitted to in usual practice. One of these showed a distinct rise in temperature, but none showed any outward signs of Rinderpest whatever.

20. Of the 6 animals that had received an injection of bile plus blood in September, 2 had died of old age and debility, but none of Rinderpest, between the September and January experiments, and the remaining 4 were submitted to the same stringent test as the other (bile) batch. One showed a slight rise in temperature on the 6th day which, however, fell on the 7th day. None of these animals showed the slightest outward signs of Rinderpest.

21. I have to add that the injection of one thousandth part of 1 c. cm. of virulent blood is sufficient to cause the usual visible symptoms of cattle plague to develop according to Dr. Kohlstock.

22. I have now to report a small series of bile experiments that have been carried out at Belgatchia.

BELGATCHIA EXPERIMENTS.

23. Amongst the various bile experiments carried out at Belgatchia, those of 11th September 1897 assumed considerable importance in regard to the duration of the immunity conferred by Bile, because three animals inoculated on this date with 10 c. cm. of bile from a bullock that had died of Rinderpest were subsequently attacked with natural Rinderpest and one died thus:

24. Bullock J. A. was attacked *four months and fifteen days after inoculation*, and died very quickly.

25. Bull J. A. 1 was attacked *four months and twenty-four days after inoculation.* His attack was very mild indeed.

26. Bull J. A. 11 was attacked *five months and five days after inoculation.* His attack was mild.

27. I think it is worth noting that these cases were immunised with bile from a bullock that died of naturally acquired Rinderpest, whereas the bile used at Kanti came from buffaloes that had been killed. It appears therefore :—

(a) That buffalo's bile under the circumstances recorded confers a longer immunity than the bile of bullocks that die of the disease.

O. 590-94.

BELGATCHIA EXPERIMENTS.

(*b*) That in the large majority of cases the *buffalo bile method*, which I have used at Kanti, confers immunity for an average period of five months at least, and probably more, but how much longer than five months the immunity lasts can only be settled by future experiment.

Practical use that may be made of the experiments.

28. These experiments tend to show that this method might be safely used with advantage on Wards' Estates, etc., when Rinderpest is known to be raging in the neighbourhood, for it would probably confer immunity long enough for the disease to die out in the surrounding villages. From the Wards' Estates its use might spread as the neighbours acquire confidence.

29. I may add that it has been clearly proved that there is no danger of the inoculation with bile conveying Rinderpest, if properly performed. It has also been proved that the operation does not interfere with the ordinary work of the bullocks

30. For the present the *buffalo bile method* is the simplest way of conferring temporary immunity on cattle in Bengal. But it has the obvious drawback that a delay occurs in obtaining the bile in necessary quantity and purity. It cannot be obtained from the cattle, for local reasons. A further delay of about 7 days occurs while the inoculated cattle are acquiring immunity, because they do not become immune at once. Hence 12 very important days, at least, are lost.

OTHER EXPERIMENTS CONNECTED WITH RINDERPEST.

31. I have made a few experiments with a view to testing the serum method of treating Rinderpest, because it has been laid down as a principle that immunity extending over a very long period can only be acquired after an attack and recovery from Rinderpest.

The preliminary difficulty is, of course, to control the strength of the attack which is to confer immunity, otherwise the animal may be killed.

Injection of blood.

32. Though I am not yet prepared to offer a definite opinion as to whether a constant control can be maintained over the virulence or mildness of the disease, it seems probable from what I have done that by injecting virulent blood into a healthy animal and immediately afterwards injecting defibrinated blood taken from an immunised case, the healthy animal becomes subject to an extremely mild attack of Rinderpest and recovers. This is what has happened in

OTHER EXPERIMENTS CONNECTED WITH RINDERPEST.

my experiments, but it remains to be seen if the attack is always as mild as has happened up to the present.

33. Should this method become recommendable for practical use it will have this advantage, *viz.*, that a mild attack of Rinderpest can be run through a herd (isolated for the purpose), and the owner's mind set at rest for, possibly, some years.

34. I do not think this method will commend itself to the raiyats of these Provinces, as it is rather too complicated for them to understand. Moreover, the dose of defibrinated blood required is large, which is also a drawback.

35. I have been for some time engaged in attempting to prepare a serum of greater immunising power than is obtained from animals that have recovered from an ordinary attack of Rinderpest.

Should I succeed, it may be possible to keep a stock of material at Belgatchia ready for distribution.

CERTAIN FACTS BROUGHT OUT BY THE INQUIRY.

36. Besides the main work reported above, a few other points have come to notice :—

A.—During outbreaks of Rinderpest calves are apt to die rather suddenly, and to show no *anti* or *post-mortem* symptoms typical of any specific disease. I mention the fact, but have not yet had time to discover the cause.

B.—The number of immune cattle round about the suburbs of Calcutta is very large, so large in fact as to infuse an element of uncertainty into experiments. Many calves have withstood infection or only had mild attacks. Buffaloes do not appear to be immune to the same extent. At any rate only one of my experimental animals has withstood infection.

C.—The number of cases of cattle plague that recover if carefully nursed is comparatively large, possibly 50 per cent.

D.—Repeated dosage with dejectæ, fibrinous casts, etc., from a Rinderpest case, has failed in some instances to produce the disease, but a subsequent injection of 10 c. cm. of blood has produced the desired result in the same animal. This experience confirms Koch's experiments in South Africa.

E.—An animal that has recovered from an attack of Rinderpest does not react in a typical manner when re-infected, but he does not seem to become absolutely immune against hypodermic injection. For I find that a hypodermic injection of virulent Rinderpest blood causes an important rise of temperature in a recovered animal, and in one case diarrhœa also occurred.

CERTAIN FACTS BROUGHT OUT BY THE INQUIRY.

F.—I have preserved bile by adding glycerine to it, as suggested by Dr. Edington, and I find that so treated, it preserves its colour, and remains free from smell for some time, at the ordinary temperature of my office in the cool weather.

Preservation of bile.

G.—A Bull suffering from Rinderpest was treated by injecting 2 oz. of bile and glycerine into the jugular vein The diarrhœa ceased within a few hours, but was resumed 2 days later, and a subsequent injection of a similar dose produced no effect whatever on the course of the disease, which, however, ended in recovery

H.—Dr. Edington's method of treating the bile is said to have the advantage that a great number of "biles," good, fair and indifferent in quality can be mixed together, and thus an average quality of bile obtained. The advantage which is said to be derivable from this system is to be found in its economy, because a quantity of indifferent material can be used up

Mixed biles.

As buffaloes are cheap in this country it seems undesirable to use risky material in order to save an occasional two or three rupees; hence the above system need not be used at present.

I.—A cutting from the *Times of India* of 25th October 1897 was sent to me detailing Dr. Edington's further experiments in South Africa. It contained the following.—"He has found that blood of animals affected by Rinderpest when treated with 'Citric Acid' and kept for such a time as to insure the death of the contagium, confers immunity from the disease when injected in animals exposed to infection." The information was misleading because citrate of potash turned out to be the agent used and not citric acid;

Treating blood with citric acid and citrates.

OXEN.	Experiments with

CERTAIN FACTS BROUGHT OUT BY THE INQUIRY.

moreover, the quantity of the drug was not stated. However, I experimented with a number of combinations of citric acid and citrate of potash, and found that a small quantity of citrate of potash prevents coagulation, but it appears to have no appreciable effect in preventing decomposition, and as blood outside a laboratory cannot be prevented from decomposing rapidly, even when a percentage of citrate of potash is added, this method, though interesting and ingenious does not appear to be suitable for Bengal at present.

Rinderpest in pigs.

J.—I gather from one of his reports from South Africa, Professor Koch does not appear to have finally decided if pigs may acquire Rinderpest. *Hence 6 young pigs have been inoculated* with large doses of Rinderpest blood, in order to solve the doubtful point as to whether they are subject to the disease.

One pig was found dead on the 15th day without showing premonitory symptoms. *Post-mortem* examination showed very severe congestion of the lungs, liver, spleen and heart. The stomach was congested, and had some petechial spots on the mucous membrane; the intestines were slightly congested. These symptoms do not point to Rinderpest, and as the other animals remained healthy, it would appear that pigs do not suffer from this disease.

Rinderpest. *(F. Raymond)* OXEN.

APPENDIX

APPENDIX.

Animals experimented upon.	Bile injection.		1st Blood injection.		2nd Blood injection		3rd Blood injection.		Minimum duration of immunity.	Remarks.
	Quantity.	Dates.	Quantity	Dates	Quantity	Dates	Quantity	Dates.		
K T 1 *Bullock*	10 c. cm.	3rd September 1897.	1 c cm.	28th January 1898	1 c cm	4th February 1898	...	.	5 months and 5 days.	All these animals lived for days with virulent Rinderpest, and slept on ground on which *Post-mortem* examinations had been held, etc., etc., etc., see body of report.
K L 2 Do .	10 ,,	3rd *September* 1897	*20 c cm*	10th September 1897	1 ,,	28th January 1898	1 c cm	4th February 1898	5 months and 5 days.	Temp. rose to 104·2° on 27th day and he was off feed. Returned to normal next day.
K L 10 Do .	10 ,,	3rd *September* 1897.	*20* ,,	10th September 1897	1 ,,	28th January 1898	1 ,,	4th February 1898.	5 months and 5 days.	
K L 3 Do .	10 ,,	5th *September* 1897	*20* ,,	16th September 1897	1 ,,	28th January 1898.	1 ,,	4th February 1898.	5 months and 2 days.	
K L 4 Do. .	10 ,,	5th *September* 1897	3 ,,	28th January 1898	1 ,,	4th February 1898.		...	5 months and 2 days	Temp. rose 1ths° F. on 6th day.
K L 13 Do .	10 ,,	5th *September* 1897	3 ,,	12th February 1898			.		5 months and 10 days.	
K L 15 *Do* .	*10* ,,	5th September 1897	10 ,,	11th September 1897	1 c. cm	28th January *1898.*	1 c cm.	4th February *1898*	5 months and 2 days.	
K L 18 *Do.* .	*10* ,,	5th September 1897	1 ,,	12th February 1898	...		...	...	5 months and 10 days.	
K L K *Do.* .	10 ,,	5th September 1897.	1 ,,	28th January 1898	1 c. cm.	4th February 1898			5 months and 2 days.	
K J 3313 Do. .	10 ,,	6th September 1897.	1 ,,	12th February 1898.	...	...	...		5 months and 9 days.	
K L 7 Do. .	10 ,,	7th September 1897	1 ,,	12th February 1898		...	...	..	5 months and 8 days.	Temp. rose from 102° to 103·4° F. on the 6th day after blood injection

O. 590-94.

G. I. C. P. O.—No 73 R & A D.—14-10-98—765.—W. G. B.

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Editor, Dr. George Watt, Reporter on Economic Products to the Government of India, Calcutta.

The objects of this publication (as already stated) are to gradually develop and perfect our knowledge of Indian Agricultural and Economic questions. Contributions or corrections and additions will therefore be most welcome.

In order to preserve a necessary relation to the various Departments of Government, contributions will be classified and numbered under certain series as well as under the specific names of the products. Thus, for example, papers on Veterinary subjects will be registered under the Veterinary Series. Those of more direct Agricultural or Industrial interest will be grouped according as the products dealt with belong to the Vegetable or Animal Kingdom, or if of a collective nature they will be placed under the Agricultural, Industrial, or Forest Series. In a like manner, contributions on Mineral and Metallic subjects will be registered under the Mineral Series in addition to that of the name of the mineral dealt with.

This sheet and the title-page may be removed when the subject matter is filed in its proper place, according to the letter and number shown at the bottom of each page.

THE
AGRICULTURAL LEDGER.

1898—No. 20.

MANURES AND MANURING.

(MINERAL PHOSPHATE.)

[*DICTIONARY OF ECONOMIC PRODUCTS, Vol. V., M. 257-59.*]

PHOSPHATIC NODULES OF TRICHINOPOLY,

AND THE USE OF MINERAL PHOSPHATES IN AGRICULTURE.

By D. HOOPER, F.I.C., F.C.S.



CALCUTTA:
OFFICE OF THE SUPERINTENDENT, GOVERNMENT PRINTING, INDIA.
1899.

Price 2 annas or 2d.

The objects of THE AGRICULTURAL LEDGER are :—

(1) To provide information connected with agriculture or with economic products in a form which will admit of its ready transfer to ledgers;

(2) To secure the maintenance of uniform ledgers (on the plan of the Dictionary) in all offices concerned in agricultural subjects throughout India, so that references to ledger entries made in any report or publication may be readily utilised in all offices where ledgers are kept;

(3) To admit of the circulation, in convenient form, of information on any subject connected with agriculture or economic products to officials or other persons interested therein;

(4) To secure a connection between all papers of interest published on subjects relating to economic products and the official Dictionary of Economic Products. With this object the information published in these ledgers will uniformly be given under the name and number of the Dictionary article which they more especially amplify. When the subject dealt with has not been taken up in the Dictionary, the position it very possibly would occupy in future issues of that work will be assigned to it.

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INTRODUCTION.

The occurrence of mineral phosphates in India has until recently been believed to be extremely rare. Isolated deposits have occasionally been found, but their minute occurrence and absence of purity in the samples have prevented their use or sale. The value of phosphatic manures is so great that at one time it was suggested that Government should offer a reward for the discovery of phosphatic minerals in paying quantities. It is only within the last decade that a somewhat extensive bed of phosphatic nodules has been explored in South India The present article is accordingly written with a view to draw attention to the possibilities of this deposit in placing within reach of planters and native cultivators a useful fertiliser for improving their crops.

OCCURRENCE. Panjab.

Nodules of calcium phosphate occur in the shales above the coal in the eocene strata of the Eastern Salt Range in the Panjab. A number of samples have, from time to time, been collected about Dandot Colliery and its neighbourhood, but the material has not been sufficient for practical use Specimens have also been reported upon from East Berar.

Berar.

Dr. Warth and Mr Parsons, in 1884, discovered coprolites above the limestone and at the foot of the black chert banks at Mussoorie.

Mussoorie.

OCCURRENCE

The calcium phosphate of the phosphorite band was all of animal origin, the nodules were genuine coprolites, and the formation of 1 to 4 inches in thickness extended more than a mile in length. An analysis of the mineral by Dr. Fraas, of Stuttgart, showed 74·5 per cent. of calcium phosphate with a trace of magnesium phosphate. This result was very encouraging, but unfortunately a large consignment was sent to England without being selected by an expert, and consequently it was found to consist largely of chert and other impurities, and yielded only a minute amount of phosphoric acid on analysis. The effect of this was that all interest in Mussoorie phosphate subsided.

Mussoorie.

Madras.

The fossiliferous rocks of the Karnatic were first brought to public notice by the late Mr. Kaye, of the Madras Civil Service, who, in company with Mr. Brooke Cunliffe, collected a large series of fossils from the limestone beds of Pondicherry, Verdachellum and Trichinopoly. The first published notice of these labours appeared in 1840 in the Madras Journal of Literature and Science.

Mr. Blanford's investigations.

This formation was subsequently investigated by the Geological Survey of India, and an elaborate paper on its history was prepared by Mr. Henry F. Blanford, and published in the Memoirs of the Survey, Volume IV. (1862).

The title of the paper is "On the Cretaceous and other Rocks of South Arcot and Trichinopoly Districts, Madras." Special attention is drawn in this article to the Utatur group of rocks and the abundance of lime in the beds. The fauna consisted of cephalopoda "intermingled in all proportions with gasteropoda and conchifera drifted together in immense numbers." The characters of the septaria nodules in the exposed clays were particularly described, but no economic value was attached to them. Mr. Blanford showed that the cretaceous strata of Pondicherry and Trichinopoly were very similar and could be separated into two distinct divisions: the lower he named the Valudayar group, which hitherto had been considered to be equivalent to the Utatur group, whilst the upper series he found to be identical with the Ariyalur group of Trichinopoly.

Dr. Warth's discoveries

Dr. H. Warth, Deputy Superintendent, Geological Survey of India, visited Utatur in the Trichinopoly District in January 1892, and came upon a rather extensive bed of phosphatic nodules. The discovery was communicated to the Secretary in the Revenue Department

of the Madras Government, and the following remarks are taken from the report :—

DR. WARTH'S REPORT.

The material occurs in nodules of about 4 inches in length in the Utatur group of cretaceous rocks. This group of sedimentary rock occupies an area of about 60 square miles in a belt which extends from a point about 15 miles north of Trichinopoly for 30 miles in a north-north-easterly direction.

Extent of deposit.

A portion of these rocks was marked in the Geological Survey map as brown gypseous shales with septaria and belemnites over an area of 6 square miles. Dr. Warth minutely examined one square mile lying midway, and on the south side, of a straight line from Nambikurchi to Nellur village in the Perambalúr taluk. It was estimated that one-tenth of a pound of phosphatic nodules per square foot lay scattered over the ravines, making roughly one thousand tons per square mile. All the ground marked as yielding septaria is not likely to be found similarly covered with nodules. They extended to a distance of three miles further south near Naikolam, but they were smaller, being only about two inches long.

Estimation of quantity.

At the close of 1892, Dr. Warth again visited the area of the cretaceous rocks in the Trichinopoly District to ascertain more exactly the extent of the distribution of the phosphatic nodules. The area occupied by the nodules was found to form a curved strip 1 mile in width and 10 miles in length. Over this area the nodules were scattered profusely on the surface of the ground wherever there were ravines and where the surface soil had been removed by erosion. Some portions of the cultivated ground were also well strewn with the nodules, but more often they were scarce on the fields, but never entirely absent. It was estimated before that the eroded area to the east of Nambikurchi *contained 0·1℔ of nodules on a square foot;* this quantity again prevailed on several occasions when trial measurements were made This amount was occasionally exceeded, and in one case, between Terani and Aynapuram, as much as two pounds per square foot were found. During the survey in a zig-zag direction across the band the following villages were passed, Utatur, Nambikurchi, Nackolum, Pervalapur, Nellur, Terani, Aynapuram, Kerai and Sirgambur.

Near Sirgambur the nodules seemed to have reached their very strongest development, as indicated by their size, up to 10 inches

DR. WARTH'S REPORT.

in length with 5 inches in diameter, yet with this village the northern boundary appeared to have been reached. On examination of the ground further west, where the geological survey had indicated concretions, it was found that the concretions were calcareous and not phosphatic. They were of much larger size than the phosphatic nodules and were easily distinguished. It was remarked that the villagers spoke of the phosphatic nodules by the Tamil name *Ammay Kolukottai*, which means certain cakes, and they have some story about them. They can at any time bring a visitor to the large nodule areas near their respective villages if he ask for Ammay Kolukottai.

Nodules prevail on the surface.

The nodules are generally scattered loosely over the ground having been washed out by the eroding action of the rainfall of centuries. Dr. Warth also noticed them *in situ* embedded in clay. There was something like a pound in a cubic foot of clay to a depth of three feet. Although it is not expected that the mineral could be profitably obtained in large quantity by excavation, yet here and there excavation would be an advantage. It was previously estimated that 1,000 tons were available in the limited area examined, but assuming that one-third of the whole area is available for the collection of nodules, and the yield 0 1lb per square foot, the whole quantity to be realized would be 4,000 tons.

These calculations may be taken as a basis of any future commercial speculation, but Dr. Warth considered the outturn could be greatly increased by the villagers themselves, who would help to extract the material all over the district.

Underground examination.

The exploration having so far been conducted on the surface, the Government of Madras requested Dr. Warth to visit and examine the area once more with the object of ascertaining the amount of phosphate contained in the underground strata. The district was accordingly visited early in 1893, and a report was submitted to Government in July.

A careful section was first made at a normal locality south-east of the village of Utatur, and an examination of the ground by means of a series of trial pits sunk across the field showed the following:—

The metamorphics terminate at a locality known as Mutia's tank. The yellow shales containing the nodules commence in a ravine and form the bulk of the section for a length of 6,000 feet. They are

sandy, and generally of a yellow colour and sometimes greenish and bluish; white veins 2 inches thick pervade the bed Fibrous and crystalline gypsum and plates of celestine occur profusely.

DR. WARTH'S REPORT.

The clays contain the fossils of the Utatur group in moderate quantities and form an almost uninterrupted series, cropping out in numerous ravines from intermediate layers of white calcareous or red sandy concretions.

The mean direction of the dip was calculated as 148°. The Ugalur area exhibits cones produced by the denudation of the clay. They are 10 feet high and are covered with either calcareous or ferruginous concretions. The latter concretions consist of rich hæmatite which at a very early time was used for iron smelting.

Conical concretions.

The phosphatic nodules lying on the surface of the ground are *the result of denudation, having been washed out of the clay of the* sandy and calcareous beds and left to accumulate in depressions A fresh estimate was made of the amount of nodules occurring on the surface along the entire length of the Utatur section The weighings gave 15lb per 100 square feet or well within the former estimate of 0 1lb per square foot.

Previous estimate confirmed.

As regards the determination of the extent of phosphates in the underground strata, excavations were resorted to. From the cubical contents of each excavation and the weight of the separated nodules, it was easily ascertained how many pounds of nodules were contained in the ground The average yield of the whole deposit was 28lb per 100 cubic feet For a depth of 200 feet, breadth of 10 miles and thickness 1,150 feet, this gives a yield of seven millions of tons. To extract the nodules below the surface of the ground would entail much labour especially in the beds where the sedimentary rocks preponderate.

Nodules in underground strata.

As the result of these explorations the Government of Madras decided to give mining leases *for one square mile to each* of the various applicants who applied for a right to extract the nodules and to levy a small royalty of two annas a ton on the outturn.

Action of Madras Government.

Chemical Composition.

The phosphatic nodules of Trichinopoly are amorphous in their structure and have no definite chemical composition, and hence cannot be regarded as purely mineral. In works on mineralogy,

COMPOSITION.

CHEMICAL COMPOSITION.

however, they are classified under the head of Apatite, and a section of the article on this mineral is generally devoted to a description of phosphatic nodules, coprolites and bone beds. The Trichinopoly deposits have been wrongly termed coprolites. Coprolites (from *Kopros*, dung, and *lithos*, a stone) consist of the petrified fæcal matter of animals, chiefly saurians, while the nodules under discussion are concretionary masses containing more or less calcium carbonate.

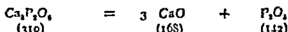
Dana's description.

Phosphatic nodules are described by Dana in the following terms :—"They occur in many fossiliferous rocks of different ages, and are probably in all cases of organic origin. They sometimes present a spiral or other interior structure, derived from the animal organization that afforded them, and in such cases their coprolitic origin is unquestionable. In other cases there is no definite or only a concretionary structure. The nodules are accompanied by the remains of marine life, of various forms of shark's teeth, etc."

With the understanding that they are of organic origin it will be difficult to apply any other more suitable term than that of mineral phosphate to the nodules of Trichinopoly. Their close association with mineral formations naturally leads one to regard them as inorganic, and the name mineral phosphate at once distinguishes them from bone phosphate, since it is well-known that the osseous system of the animal kingdom consists largely of the same chemical constituents with varying proportions of other elements.

The nodules contain for the most part a compound of lime, known as tricalcic or tribasic phosphate, with smaller quantities of iron, alumina, magnesia, silica and carbonic and sulphuric acids.

The formula for calcium phosphate is $Ca_3 P_2 O_8$, a chemical body which may be regarded as a compound of calcium oxide or lime ($Ca O$) with phosphoric anhydride ($P_2 O_5$), commonly called phosphoric acid.



$$\underset{(310)}{Ca_3P_2O_8} = \underset{(168)}{3\ CaO} + \underset{(142)}{P_2O_5}$$

From the atomic weights placed below the formulæ in the above equation, it can easily be calculated that 100 parts of calcium phosphate consist of 54·2 parts of lime and 45·8 parts of phosphoric anhydride.

Percentage composition.

The value of coprolites depends not only on the richness of the above two elementary substances, but also on the absence of iron and

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alumina compounds, since, in the preparation of superphosphate, the sulphuric acid attacks iron and alumina before it decomposes the phosphate, and thereby a loss is occasioned. In order to obtain a conclusive opinion on their actual composition the Madras Government considered it necessary to have the Trichinopoly nodules completely analysed by expert analytical chemists in England. A consignment of one ton of the mineral was accordingly collected at Utatur in 1892 by Dr. Warth and transmitted to London for this purpose.

CHEMICAL COMPOSITION.

Analysed in England.

The analyses were duly conducted, and in forwarding the reports on the Trichinopoly phosphates to the Madras Government, H. M.'s Secretary of State remarked :—

"With reference to your letter, No. 13, Revenue, of the 22nd of July last, forwarding, for chemical analysis, samples from the deposit of phosphate nodules recently discovered in the Trichinopoly District by Dr. Warth, I enclose a copy of the analysis of the same made by Dr. Augustus Voelcker and Mr. King. Further analyses are expected from Professor Dewar and Sir John Lawes, Bart., which on receipt will be duly forwarded to you."

Secretary of State's remarks.

"It is satisfactory to observe that Dr. Voelcker and Mr. King's analyses confirm those sent with Your Excellency's letter; but, as remarked by Dr. Voelcker in the Report sent with his analysis, the practical question for consideration is whether it would be profitable to reduce the nodules at Utatur to superphosphate unless the deposit is found, on further examination, to be deeper than Dr. Warth first calculated, or that formations equally rich in phosphate exist elsewhere within the limits of the Madras Presidency. The cost of machinery and chemicals for the treatment of 60,000 tons of nodules would probably more than equal that of the importation from the United Kingdom or the United States of America of any manufactured superphosphates required in India."

ENCLOSURE NO. 1.

From Mr. J. A. Voelcker, *Analytical Laboratory, 22, Tudor Street, New Bridge Street, London, dated 18th November 1892.*

Dr. Voelcker's report.

I have pleasure in handing you my Report on the sample of phosphate which you forwarded to me for examination, and which, I am informed, is taken from an extensive deposit recently discovered in the Trichinopoly District of the Madras Presidency.

MANURES & Manuring.

Phosphatic Nodules of Trichinopoly:

CHEMICAL COMPOSITION.

Dr. Voelcker's report.

The whole of the 1 cwt. sent to me was first roughly broken, an average sample was taken, reduced to fine powder, intimately mixed and then subjected to analysis.

The results obtained were as follows :—

Moisture	1·53
Water of combination and organic matter	2·85
Phosphoric acid *	26·05
Lime	45·51
Oxide of iron	3·14
Alumina	2·63
Magnesia	·34
Sulphuric acid	·60
Carbonic acid †	7·23
Fluorine and alkalies	4·84
Insoluble siliceous matter	5·28
TOTAL	100 00

The deposit is essentially a *phosphatic* one, but it is not a true coprolitic deposit, in the sense of being presumably fossilized excreta. It consists of phosphatic nodules (phosphate of lime), which, by infiltration of water charged with carbonic acid, and holding dissolved carbonate of lime, have, on evaporation of the water, become filled in with carbonate of lime to a considerable extent. The amount of carbonate of lime varies much throughout the sample, some of the nodules having a great deal of it, and being in consequence less rich in phosphate, while others are much freer from the admixture and consist mainly of phosphate of lime alone. It would, however, be clearly impossible to separate the one kind from the other in any working plan, and, therefore, the analysis was made in a sample representing an average of the whole.

The amount of phosphate of lime, 57 per cent. nearly, is fairly high, and in this respect the deposit compares favourably with most of those in North and South Carolina, and with the coprolitic deposits found in different parts of England. Besides this, the percentage of insoluble siliceous matter is small, and the phosphate should be judged from these points, a useful phosphatic supply. But there are some drawbacks which require to be pointed out, and

* Equal to tribasic phosphate of lime, 56·87.
† Equal to carbonate of lime, 16·43.

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which would militate against the value of the material as the basis for the manufacture of "superphosphate," the use to which phosphatic minerals are most generally put.

CHEMICAL COMPOSITION.

Dr. Voelcker's report.

Although a small quantity of carbonate of lime is an advantage rather than the reverse, the presence of a considerable quantity, as here, involves the waste of sulphuric acid (oil of vitriol) when the material is dissolved in the acid for manufacture into superphosphate.

Another drawback is, that the amount of iron and alumina (together nearly 6 per cent.) is very high. The effect of so much iron and alumina, in a phosphate, is to prevent a good, nicely manufactured superphosphate being made, and the soluble phosphate, formed by treatment of the material with acid, is lower in amount, and is likely to lessen still more on keeping On account of this property of oxide of iron and alumina, phosphates which contain any considerable amount of them are reckoned unsuitable for manufacture, and would not find a sale in this country.

It is very doubtful whether for export purposes it would pay to ship the material, even if the cost of working, carriage to port of shipment, and freight to this country, were favourable. Large quantities of Carolina phosphate are shipped from America to this country yearly, and the amount of phosphate of lime is not more than in the present sample from Trichinopoly. Freights, however, are very low from America, and the Carolina phosphate is particularly well adapted to the manufacture of superphosphate. Carolina phosphate contains very little oxide of iron or alumina, and no large quantity of carbonate of lime. It is sold here on the basis of its percentage contents of phosphate of lime, a certain price per unit per ton for this ingredient being fixed At present, the price of the unit is about 6*d*. Valued in this way, the new phosphate would fetch about 28*s*. 6*d* per ton in the market, but, as I have hinted, owing to the drawbacks, this price would be subject to certain deductions.

Compared with Carolina phosphate.

I think it improbable that the material could be remuneratively exported for manufacturing purposes. It remains to consider whether it could be manufactured into superphosphate in India itself, or be used in some other way in the country. The former will depend on the price of, and facilities that exist for, obtaining sulphuric acid (oil of vitriol) and the cost of the other manufacturing processes. It would be necessary to make inquiries on these

CHEMICAL COMPOSITION.

points. I may, however, state for your guidance that superphosphate of the quality which this material would probably supply can be at present obtained in England for 50*s*. or 52*s*. per ton. If to this the cost of freight be added, it can be seen, after inquiry, whether the manufacture in India could be conducted at a less cost. Personally I do not think that it could be. There might be some demand for the superphosphate among tea, coffee, and perhaps indigo planters, but hardly, I imagine, among the cultivating ryots.

Finally, I think that the best use that could be made of the material would be to set up a mill on the spot, for crushing and grinding it into fine powder, and to then use it, in its unmanufactured state direct on the land as a manure. The presence of carbonate of lime would then form no objection, and the phosphate would be useful as a fertiliser to crops generally, though of a somewhat slowly acting nature.

ENCLOSURE No. 2.

Mr. J. F. King's report.

Report of Analysis by Mr. J. F. King, Analyst to the Edinburgh Agricultural Association, of sample of phosphate of lime received from Sir G. Birdwood, Whitehall, S. W., on 15th November, 1892. One hundred parts of this sample contained the following constituents:—

Phosphoric acid *	27·04
Lime	46·88
Organic matter, combined water, etc.	4·86
Magnesia, sulphuric acid, etc.	3·22
Alumina and iron oxide	3·96
Carbonic acid	10·30
Moisture	0·94
Silica	2·80
TOTAL	100·00

The foregoing results show that this is a valuable phosphatic material. It contains a very good supply of phosphoric acid, and though it contains, like many other mineral phosphates, a considerable amount of iron oxide and alumina, the quantity of these substances which is present is not higher than that which I find in many phosphates in common use. The amount of useless siliceous matter is

* Equal to tribasic phosphate of lime, 59·00.

CHEMICAL COMPOSITION.

Mr. J. F. King's report.

not great, and although the amount of carbonic acid is rather high, this will be of some use when the material is made into superphosphate.

The phosphate is hard, but it is brittle, and it is therefore tolerably easily ground.

From the results of my analysis I have come to the conclusion that this phosphate, although it cannot rank with phosphates of the highest class, is yet one of a very valuable description, and is one which will serve very well for the manufacture of artificial fertilisers. I have made some superphosphate from it, and judging by the sample of the result which I send herewith, it will be seen that, so far as appearance goes, it is of excellent quality."

Further analyses.

Selected samples of the nodules had previously been analysed at the Geological Laboratory, Calcutta, and were found to yield 57, 58, 64 and 67 per cent. of phosphate of calcium, or an average of 61 per cent., while a general mixture from a heap of half a ton gave 51 per cent. of phosphate.

The following analysis of an average sample of Trichinopoly phosphates was made by the writer in July 1893 for Messrs. T. Stanes & Co., Coimbatore:—

Moisture	1·53
Combined water and organic matter	2·66
Phosphoric acid *	24·58
Lime	43·51
Oxide of iron and alumina	8·62
Magnesia	·29
Sulphuric acid	·50
Carbonic acid †	7·38
Alkalis, etc.	2·43
Insoluble siliceous matter	8·50
	100·00

The following four analyses may be of interest in showing the composition of the nodules collected at Utatur compared with the

* Equal to tribasic phosphate of lime . . . 53·65
† Equal to carbonate of lime . . . . 16·77

MANURES & Manuring. Phosphatic Nodules of Trichinopoly:

CHEMICAL COMPOSITION. Further Analyses.

powdered phosphate after it is ground in the factory and as supplied to the public. The samples were analysed in 1894-95.

1. Soft phosphate from the surface, Utatur.
2. Hard phosphate from below surface, Utatur.
3. Ground phosphate from Messrs. Arbuthnot's factory, Calicut.
4. Phosphate from a planter, Wynaad.

	1.	2.	3.	4.
Moisture and organic matter	4·75	4·30	3·95	3·90
Phosphoric acid	24·85	27·60	27·38	20·29
Lime	38·75	43·51	43·04	42·42
Iron and alumina	9·85	3·77	6·32	11·67
Alkalis, etc.	4·10	2·99	4·69	
Carbonic acid	7·28	5·20	7·10	7·62
Sandy matter	10·42	12·63	7·52	8·10
	100·00	100·00	100·00	100·00
Tricalcic phosphate	54·24	60·25	59·77	57·39
Calcium carbonate	16·54	11·81	16·14	17·31

With regard to sample No. 4, it might be remarked that it was forwarded to the writer for analysis and report on its purity. The result indicates that the specimen was up to the average of the quarried mineral and was free from adulteration.

In connection with these analyses of Trichinopoly nodules it will be of interest to quote, for purposes of comparison, some of the more important phosphate deposits of the world and the percentages of phosphoric acid contained in them—

Values of the chief phosphate deposits.

Cambridge coprolites	26·6
Suffolk "	25·2
Bedfordshire "	21·0 to 25·0
German apatites	30·9 to 35·7
French phosphate	33·7 to 35·5
Norwegian chlor-apatite	35·6
Spanish phosphorites	36·3 to 39·0
Canadian apatite	33·5 to 41·5
West Indian phosphates	36·0 to 48·8
South Carolina (fossiliferous)	22·0 to 28·4

As far as the proportion of pure phosphate is concerned, the Trichinopoly nodules rank with the English coprolites and the fossiliferous deposits of South Carolina. They do not approach the superior forms of coprolite which are largely exported to countries where agricultural superphosphate is manufactured. Their value on this account will be only locally appreciated.

M. 257-59.

THE USE OF MINERAL PHOSPHATE.

The chief use of coprolites and phosphorites is in the preparation of superphosphate or soluble phosphate of lime. This compound is manufactured by treating them in a powdered condition with sulphuric acid, or as it commonly called 'oil of vitriol.'

In a powdered condition

Mineral phosphate may also be successfully employed in a raw state, provided it has been reduced to a fine state of division by means of a grinding mill or disintegrator. The phosphate, even in a disintegrated state, is not soluble in water, but the action of the soil and the rootlets of plants render them in the course of time available to the crop. Ground phosphate forms a good compost with farm-yard or stable manure, or when mixed with refuse heaps consisting of much vegetable matter. Professor Graham, F.R.S, was the first to show that, by the addition of mineral phosphates to fermenting dung, the insoluble phosphates they contain are partly rendered soluble. Hence soils which are most benefited by the ground mineral phosphates are those rich in carbonaceous and nitrogenous organic matter represented by humus

Amount applied per acre.

Mineral phosphates are not so readily absorbed by the crops as superphosphates and they are necessarily used in larger quantities. From 7 to 10 cwt. per acre for barley are the usual quantities recommended, the manure being harrowed into the land. For pasture land the powder may be applied as a top dressing in wet weather in the proportion of 10 cwt. per acre. Ground mineral phosphates are also used for root crops in the same proportion (*Griffiths*).

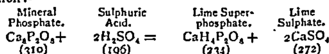
The deficiency in certain Indian soils of phosphoric acid is a sufficient reason for advocating the use of phosphatic manures, and the results that have attended experiments in this direction show a decided benefit to the crops.

Manufacture of superphosphate.

The manufacture of superphosphate from coprolites is effected by the action of oil of vitriol. The phosphate must be in the form of a fine powder, and the addition of sulphuric acid converts it into tetra-hydric phosphate of lime and sulphate of lime. The resulting mixture contains a large quantity of water which is evaporated off at a

USE OF MINERAL PHOSPHATE.

low temperature. The chemical change is expressed by the following equation:—



Mineral Phosphate.	Sulphuric Acid.	Lime Superphosphate.	Lime Sulphate.
$Ca_3P_2O_8 +$	$2H_2SO_4 =$	$CaH_4P_2O_8 +$	$2CaSO_4$
(310)	(196)	(234)	(272)

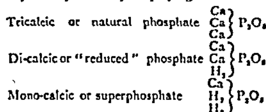
The figures beneath indicate the actual combining proportions from which it may be calculated that 112℔ (1 cwt.) of pure tricalcic phosphate require 70℔ of sulphuric acid to completely effect the decomposition. Owing, however, to the character of the impurities such as oxide of iron, alumina and carbonate of lime, the amount of sulphuric acid is in practice much exceeded.

"Reduced" phosphate.

If superphosphate be allowed to remain in storage for any considerable time, it reverts to the less soluble condition di-hydric di-calcic phosphate known as "reduced" phosphate; this retrograde phosphate, however, is of more value to the agriculturist than the crude mineral in a powdered state. Reduced phosphate is a di-basic phosphate, and may be made from the Trichinopoly nodules by converting two-thirds into superphosphate and mixing it with one-third of the crushed raw material.

Relation between the phosphates.

The chemical relation that exists between the three varieties of phosphates may be explained by employing the following formulæ:—



Tricalcic or natural phosphate $\left.\begin{matrix}Ca\\Ca\\Ca\end{matrix}\right\}P_2O_8$

Di-calcic or "reduced" phosphate $\left.\begin{matrix}Ca\\Ca\\H_2\end{matrix}\right\}P_2O_8$

Mono-calcic or superphosphate $\left.\begin{matrix}Ca\\H_2\\H_2\end{matrix}\right\}P_2O_8$

The first is insoluble in pure water, the second is partly soluble in solutions of carbonic acid and citrate of ammonia, while the third compound, when freshly prepared, is freely soluble in water.

The standard of valuation of all these fertilisers is the percentage of phosphate soluble in water, but it does not necessarily follow that the pulverised mineral or reduced phosphate is less valuable as a plant food. The question for the farmer is not one of water solubility, but of assimilability of the manure, and until we know more about the natural decomposition induced by the soil and the action of root hairs, before it is rendered available for the plant, artificial tests lead only to conjecture.

USE OF MINERAL PHOSPHATE

It has been observed that superphosphate after prolonged storage and consequently becoming of less value in the market on account of the increase of insoluble constituents, is found more effective on the land than newly-made superphosphate.

In 1880, Mr. T. H. Thursfield, of Barrow, Shropshire, made a very interesting experiment illustrative of the above facts. "He had for several years found decided advantage by reducing the superphosphates for his own use, as he could not purchase "reduced" superphosphate. He adopted the excellent plan of adding one ton of quarter-inch bone to every two tons of superphosphate. The bones are moderately moistened, and then mixed into a heap with the superphosphate. In a few days great heat was produced, and this heat continued, but after five or six weeks the manure was ready for use. The practical result of this action is to reduce the solubility of the superphosphate, and increase the solubility of the bone. The superphosphate, however, was improved as a manure, but it was spoilt for analysis by reason of its having so little phosphate remaining in a soluble condition, and this is necessary for the market standard. The result proved that 27*s.* expended in this manure produced as heavy a crop of swedes, and of as high-feeding quality as 45*s.* 6*d.* in other artificial manure of high quality, with ten loads of farmyard manure in addition." (*Prof. Tanner, Agricultural Practice*, page 210.)

Value of dicalcic phosphate.

These experiments show that the possibilities of phosphatic deposits, such as those of Trichinopoly, are far reaching. The nodules may be employed in one of three conditions, as a simple powder, as a high grade superphosphate, or as an intermediary product prepared by intimately mixing two parts of the super or acid phosphate with one part of the ground mineral.

EXPERIMENTS WITH PHOSPHATES IN AGRICULTURE.

EXPERIMENTS WITH PHOSPHATES.

Agricultural records in India contain no systematic results of experiments having been made with simple phosphatic manures applied to indigenous crops. The failure to grow particular cereals, such as oats and barley, in certain areas might be traced to the absence of some fertilising constituent in the soil. The following experiments were made in the Botanic Gardens, Ootacamund, with a view to discover

Ootacamund.

EXPERIMENTS WITH PHOSPHATIC MANURES.

if phosphates would favourably affect the growth of oats, mustard and lucerne, which are, as a rule, not very easily cultivated on the Nilgiris.

The seedlings of these plants were put out in boxes in the middle of June 1895. One box of each was left unmanured. The second box was manured with finely powdered Trichinopoly nodules on the 1st of August. The third box of each was treated at the same time with ground superphosphate made from the nodules. The plants were left for four months with occasional watering, and on 1st December they were cut down.

Lucerne

The whole of the lucerne was in a flourishing condition. The plants without manure were six inches high, with crude phosphate, the average height was nine inches, and with superphosphate ten inches.

Oats.

The oats proved to be very succeptible to the fertilising action of the minerals. Without manure, the plants were sickly and yellow, and the tallest was only 1 foot 6 inches high; only one of these plants produced grain. The plants treated with phosphates were green, healthy and fruited freely, and no failures were noticed. The plants growing in mineral phosphate were 2 feet 7 inches, and in the superphosphate bed 2 feet 8 inches.

Mustard.

The mustard plants afforded the most remarkable differences in their yielding to the stimulating influence of manures. The unmanured plants were two feet high with the fruit commencing to form. In the bed treated with phosphates only the highest plant was 3 feet 3 inches. But in the soil mixed with superphosphate the highest plant reached 6 feet 5 inches. It is not too much to suppose that the sulphate of lime in the superphosphate contributed largely to the luxuriant growth of these plants.

The green portions of the plants were cut down and weighed, they were then carefully dried in a water-oven and weighed again. The figures below give the weights of the fresh and dried crops. The figure No. 1, it must be understood, refers to the unmanured sample, No. 2 to the plants treated with mineral phosphate, and No. 3 to those growing in soil mixed with superphosphate:—

Weight of plants.

	Weight of green plants in grams.	Weight of dried plants in grams.	Percentage of water.
	LUCERNE.		
No. 1 .	8·5	1·8	78·82
„ 2 .	15·5	3·2	79·29
„ 3 .	21·0	4·5	78·57

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" 3 .	25·0	6·5	74·00
	MUSTARD.		
No. 1 .	21	3·5	83·33
" 2 .	48	7·5	84·37
" 3 .	170	32·2	81·05

Here the benefit derived from the use of phosphatic manures is unquestionable. In the cases of lucerne and mustard, the phosphate alone has doubled the outturn of the green aerial portions of the plants. The superphosphate has nearly trebled the weight of lucerne, and increased the yield of mustard nearly ten-fold. As regards oats, the phosphates, both soluble and insoluble, have converted their cultivation in Nilgiri soil from a failure to a success.

An estimation of the ash was made of these plants and the proportions of lime and phosphoric acid were determined. The following table gives the relative amounts of these elements removed by the plants from the soil:—

Weight of ash, etc.

	Ash.	Lime (CaO)	Phosphoric anhydride (P_2O_5)
	LUCERNE.		
No. 1 .	·211	·043	·029
" 2 .	·419	·091	·060
" 3 .	·566	·126	·084
	OATS.		
No. 1 .	·021	...	...
" 2 .	·653	·029	·049
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	MUSTARD.		
No. 1 .	·466	·053	·035
" 2 .	1·039	·184	·073
" 3 .	3·158	·443	·202

In 1896, the writer had an opportunity of testing the effect of phosphatic manures on the growth of the tubers of the medicinal jalap (**Ipomœa purga**). The following remarks are taken from a report that was drawn up on that occasion, and may interest those engaged in acclimatising economic plants.

The question of manuring is one of great importance in cultivating drugs for the purpose of increasing their active principles. It has

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EXPERIMENTS WITH PHOSPHATIC MANURES.

Jalap.

been proved over and over again in cinchona culture that nitrogenous and phosphatic manures increase the amount of alkaloids in the bark; on the same principle potash is good for tobacco crops, and magnesia and lime cause a development of sugar in the sugar-cane. There is no doubt that better results would be obtained in growing medicinal plants if attention were directed to a proper system of applying suitable fertilising agents to the crops.

With regard to the *Nilgiris*, it is known that there is a deficiency of lime and phosphoric acid in the soil, and an addition of these two ingredients has always proved beneficial to the local tea, coffee, and cinchona estates.

For the purpose of observing the action of these substances on the growth of jalap tubers, and the effect they would have of increasing the active principle, an experiment was made in which some powdered mineral phosphate and superphosphate were employed. Into one box was placed some ordinary soil of poor quality; in the second the soil was mixed with some mineral phosphate from Trichinopoly in the proportion of 10 cwt. an acre, and in the third the soil was mixed with superphosphate in the same proportion. In each of these boxes was planted a small jalap tuber, and the boxes were left undisturbed for nine months. The plant that grew from the tuber in the third box was much taller than that in the second, and the plant in the second was much more luxuriant than that in the first. The subterranean portion of the plants corresponded with the aerial growth, for when they were taken up the tubers were found to have developed remarkably in the manured soil.

The respective weights were as under:—

	Fresh.	Dry.	Per cent. of Water.
No. 1. Unmanured	32	7·62	76·2
„ 2. Phosphate	85	22·44	74·2
„ 3. *Superphosphate*	228	54·20	76·2

The percentage of resin was then estimated in the dry powder with the following results; the amount of ash was also taken in each sample:—

	Resin.	Ash.
No. 1	10·49	4·95
„ 2	11·97	4·38
„ 3	13·79	4·30

Considering that the tubers were taken up before they were fully grown, and before they were of the size usually seen in commercial

EXPERIMENTS WITH PHOSPHATIC MANURES.

Jalap.

circles, the result of the application of phosphatic manure was most satisfactory, not only in increasing the weight of the tubers, but also in increasing their value in the amount of active principle.

Ipecacuanha.

Another medicinal plant which has been tried in various places in India with indifferent success, is the Ipecacuanha (**Psychotria Ipecacuanha**), a native of Brazil. This has been introduced in Burliar, Kulhutti and Ootacamund on the Nilgiris, Nilambur in Malabar, and Mungpoo in the Darjeeling district, but adverse conditions of climate or soil have hitherto affected its growth in these localities. In August 1896 the writer instituted a series of experiments with these plants in the Government Botanic Gardens, Nilgiris. Several young cuttings of the average height of six inches were planted out in four boxes of prepared soils. Box No. 1 contained an admixture of calcium superphosphate; box No 2, powdered phosphate from Trichinopoly; box No. 3, dried cattle manure, and the soil in box No 4 was left in its natural state. The plants were completely uprooted in September 1898, or after they had been two years under treatment, and the results of the experiments were carefully recorded by Mr. R. L. Proudlock, the present Curator of the Gardens. One or two cuttings in each box had partly or wholly died during this period, so the results are calculated on the three largest plants in each box. The average height of the plants in box No. 1 was 11¼ inches; No. 2, 12⅓ inches; No. 3, 11⅓ inches; and in No. 4, 11⅓ inches. The height of the plants has thus uniformly increased irrespective of the manures employed.

The roots were separated from the stems, washed in water to remove adhering soil, and then thoroughly air-dried and accurately weighed. By calculation of these results the following instructive conclusions were arrived at:—

In superphosphate the average root weighed			·5·6	grams.
„ powdered phosphate	„	„	„ ·5·3	„
„ cattle manure	„	„	„ ·5·3	„
„ ordinary soil	„	„	„ ·2·6	„

These figures clearly demonstrate that the most valuable portion of the ipecacuanha plant gives double the yield when grown in the presence of phosphatic manures compared with that produced in natural soil.

The above recorded experiments, although performed on a somewhat small scale, go far to illustrate the beneficial employment of mineral phosphate in Indian agriculture.

M. 257-59.

G. I. C. P. O.—No. 429 R. & A.—8-3-99 —2,200.—W. DeBarros.

All communications regarding THE AGRICULTURAL LEDGER should be addressed to the Editor, Dr. George Watt, Reporter on Economic Products to the Government of India, Calcutta.

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